MATHEMATICS 51

517.392 : 621.3.012

1. Method of integration by successive points (step by step method) applied to electric circuits. G. GILLON. *Rev. Gén. Elect.*, **58**, 192–8 (*May*, 1949) *In French.*

The equations describing transients in L-C-R-circuits are solved by a step-by-step method. Some examples are given. The method is accurate enough for deriving the curves showing the variation of the current and potential with time. The circuit constants may be constant or variable. L. S. GODDARD

517.947.43 : 536.2.01/.02

On a solution of Fourier's equation. *See Abstr.* 216

518.5 : 621.317.39

2. An electro-mechanical device for solving non-linear differential equations. C. A. LUDEKE. *J. Appl. Phys.*, **20**, 600–7 (*June*, 1949).

Deals with equations of type

$$d^2\theta/dt^2 + F_1(\theta,t)(d\theta/dt)^n + F_2(\theta,t) = F_3(t)$$

The variation of θ with t is obtained as the motion of a pivoted beam, subjected to forces which correspond to the terms of the equation. These forces may be produced by solenoids which attract iron plungers on the beam, and which are magnetized by currents which vary with time according to the form of F_1 and F_2. Separate circuits are used to generate these currents. Terms may also be generated by sets of inclined springs. Tests show that the instrument can be set up with the required accuracy.

N. CORCORAN

518.5 : 621.318.572

3. Realization of matrices by amplifiers and the solution thereby of systems of differential equations. G. L. POLISAR AND N. V. KOROLKOV. *Elektrichestvo (No. 7)* 77–80 (*July*, 1948) *In Russian.*

Many problems involve the solution of systems of ordinary differential equations with constant coefficients. These can be expressed in matrix form and a suggestion of L. I. Gutenmacher leads to experimental methods for their solution. A network capable of handling 12 equations is described, consisting of 6 amplifiers each with an output potentiometer feeding 6 conductance-capacitance parallel-connected circuits. The conductances represent the invariable terms and the capacitances the terms associated with the differential operator in the matrices; the magnitudes of the matrix terms are represented by the positions of the potentiometer feeding points. Adjustments are controlled by observation of a c.r. display. The use of the apparatus is illustrated by the solution of two numerical examples.

B. HAGUE (R)

518.5 : 621.318.72 : 621–526

4. General theory of electronic circuits and their application to automatic computors and servos. III. Linear differential equations with periodic coefficients. J. BALTÁ, A. G. DEL VALLE AND J. A. G. GARCÍA. *An. Real. Soc. Esp. Fis. y Quím.*, **44**, 211–18 (*March–April*, 1948) *In Spanish.*

Shows how the solution of a given second-order differential equation may be obtained as the charge on a condenser, whose elastance (reciprocal capacitance) is sinusoidally modulated, in series with an inductance modulated in a complementary manner. The condenser may be synthesized as C_2 and C_2' in series, the voltage across C_2 being fed into a pentode P_2, thence into a differentiating coil M_2, and a pentode P_2' which feeds current into C_2'; the gain of P_2 is sinusoidally modulated. An analogous arrangement enables the inductance to be realized.

F. F. ROBERTS (R)

518.5 : 621.318.572 : 621.389

5. Electronic techniques applied to analogue methods of computation. G. D. MCCANN, C. H. WILTS AND B. N. LOCANTHI. *Proc. Inst. Radio Engrs*, **37**, 954–61 (*Aug.*, 1949).

Describes in detail the electronic devices and principles that have been developed for the California Institute of Technology (CIT) electric analogue computer. A detailed discussion is given of the devices for generating the arbitrary functions of the independent variable (the excitation functions), the amplifiers for producing active linear elements such as negative impedances and for representing the non-symmetrical terms of the matrix specifying the differential equations, the multipliers for producing arbitrary functions of the dependent variables (non-linear elements). A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.2 : 535.83

6. Some recent applications of optics to astronomy. E. H. LINFOOT. *Mon. Not. Roy. Astr. Soc.*, **108** (*No.* 1) 81–93 (1948).

Describes the two aspheric mirror telescopes of Schwarzschild, the Schmidt camera, the Maksutov meniscus telescope, and variants of the latter two.

H. H. HOPKINS

522.21

7. First photographs with the 200-inch Hale telescope. E. HUBBLE. *Publ. Astr. Soc. Pacif.*, **61**, 121–4 (*June*, 1949).

Stars and nebulae were recorded fully 1·5 magnitudes fainter than the threshold of the 100 in. A turned-up edge (known to exist from Hartman tests) prevented maximum efficiency only on rare nights of exceptional seeing. The coma-free field, 5′ in diameter, can be increased to 15′ by using a Ross correcting lens at 160 in aperture. M. W. OVENDEN

523.11 : 530.12

8. Cosmological application of relativity. G. LEMAÎTRE. *Rev. Mod. Phys.*, **21**, 357–66 (*July*, 1949).

The following topics are considered: 1. Time as co-ordinate, introduction of proper time through a metric of space time. 2. Geometrical description of matter, the cosmical constant as a second constant

demanded by the logical structure of the theory. 3. Detailed computation of the gravitational equations for a general non-static field of spherical symmetry. 4. Schwarzschild's and de Sitter's solutions free from artificial singularities. 5. Map representation of elliptical space, expanding space, Friedmann's equation, reduction to elliptic functions, numerical results. 6. Geodesics of space time, application to proper velocities and red-shift. Discussion of the time scale, numerical value of the cosmical constant data on density. 7. Use of statical co-ordinates, the instability of Einstein's universe when no restriction is imposed on the symmetry of fluctuations, formation of the nebulae from fast-moving clouds of gases. 8. Discussion of the problem of the clusters of nebulae. 9. The cosmic rays as remnants of primitive matter. Explanation of the large amount of H and He in the stars. A.

523.47

9. The fifth satellite of Uranus. G. P. KUIPER. *Publ. Astr. Soc. Pacif.*, **61**, 129 (*June*, 1949).

Report of discovery.

523.67 : 535.338.4

10. Carbon monoxide emission in the region of the 4 050 Å group in cometary nuclei. R. HERMAN. *C.R. Acad. Sci., Paris*, **228**, 1691–3 (*May* 30, 1949) *In French.*

Lab. experiments, using a H tube with C electrodes, indicate a new system of CO triplets with wavelengths close to the band heads of CH_2. It is suggested that these are present in cometary spectra, modifying the positions and relative intensities of the components of the "4050" group. Further work is in progress.

D. L. EDWARDS

523.74

11. On the sizes of photospheric granules in the neighbourhood of sunspots. C. MACRIS. *C.R. Acad. Sci., Paris*, **228**, 2010–11 (*June* 27, 1949) *In French.*

Granules at a distance are found to be slightly > those near a sunspot. R. A. NEWING

523.743

12. On the dimensions of photospheric granules. C. MACRIS. *C.R. Acad. Sci., Paris*, **228**, 1792–4 (*June* 8, 1949) *In French.*

Photographs by Lyot with a filter (max. 5 500 Å) were measured; a mean diameter of 1·70″ reduces to 1·5″ when corrected for diffraction effects. Diameters are in the range 0·9″ to 2·1″, with Gaussian distribution. M. W. OVENDEN

523.746.5

13. The probable behavior of the next sunspot cycle. W. GLEISSBERG. *Astrophys. J.*, **110**, 90–2 (*July*, 1949).

The probability laws of sunspot variations, which have yielded successful predictions for the present sunspot cycle, lead to the conclusion that, with a high degree of probability, a steep ascent to a very high max. is to be expected also in the next cycle and that the period of low activity preceding the next cycle probably will be extremely short. A.

523.746.5

14. Note on the physical significance of Stewart's sunspot formula. W. GLEISSBERG. *Astrophys. J.*, **110**, 94–5 (*July*, 1949).

523.75

15. Observations of the corona during the eclipse of 1 November 1948. M. WALDMEIER. *Z. Astrophys.*, **26** (*No.* 1) 1–6 (1949) *In German.*

Observations of the coronal lines 5 303 and 6 374 Å obtained with the coronagraph of the Arosa Astrophysical Observatory. A.

523.75

16. Solar prominence distribution during 1942–1945. L. LARMORE. *Ann. Harv. Coll. Obs.*, **120** (*No.* 1) 77 *pp.* (1949).

Measurements of prominence photographs are tabulated for about 3 000 prominences photographed with the Harvard Coronagraph at Climax, Colorado, from 1942 through 1945. Solar position angles, angular spreads, intensity estimates and areal measures are given. Histograms are given showing that 4-month averages of prominence area for both *S* and *N* hemispheres of the sun reached a min. in January–April, 1944, and that average latitudes of high latitude prominences increased for the *N* solar hemisphere, but not for the *S*. A.

523.755 : 522.615 : 535.247.4

17. Photoelectric photometry of the solar corona. H. WILLE. *Naturwiss.*, **36** (*No.* 1) 25–6 (1949) *In German.*

Advantage is taken of the weak polarization ($\sim 10\%$) of the coronal light to modulate the current output of a photo-cell by interposing a rotating $\lambda/2$ plate, and polarizer in the incident light beam. The large component ($\sim 10^4\times$ coronal light) of scattered sunlight is unpolarized, and yields a steady photocurrent which may be filtered from the amplifier output. Thus the rectified a.c. component of the output will be $\propto$ the incident coronal light.

D. R. BARBER

523.84.035.92

18. An ultraviolet light-curve of *V* 444 Cygni. W. A. HILTNER. *Astrophys. J.*, **110**, 95–8 (*July*, 1949).

523.841

19. A spectrophotometric investigation of Nova *T* Coronae Borealis 1946. R. BRAHDE. *Stockholms Obs. Ann.*, **15** (*No.* 7) 3–22 (1949) *In English.*

Intensity curves of the spectra of this recurrent nova are reproduced for 5 dates in 1946 and tables given of wavelengths, identifications and intensities of the stronger emission lines. These include 3 strong corona lines of [Fe x], [Fe xiv] and [Ni xii]. A depression of the continuum between Hβ and 4 686 is attributed to MgH absorption, supported by coincidences of other absorption lines with wavelengths of MgH band heads. A summary of early observations from 1866 is included. D. L. EDWARDS

523.841.1

20. The spectrum of Nova Persei 1901. D. B. MCLAUGHLIN. *Publ. Obs. Univ. Michigan*, **9** (*No.* 3) 13–71 (1949).

A detailed organized account of all available spectrographic observations of the nova, and photographic and spectrographic observations of the associated nebulosities, is given. The detailed application of the author's general model [*Publ. Obs. Univ.*

Michigan, **8**, 188 (1943); *Publ. Astr. Soc. Pacif.*, **59**, 244 (1947)] to N. Persei is discussed, with a short criticism of Mustel's conclusions [Abstr. 2897, 2898 (1949)]. An appendix gives a summary of the spectrum changes in diary form. M. W. OVENDEN

523.841.3

21. The spectrum of Nova *T* Coronae Borealis during the explosion of February 1946. L. GRATTON AND E. C. KRÜGER. *Mem. Soc. Astr. Ital.*, **20** (*No.* 3) 197–225 (1949) *In Italian.*

523.842

22. Detailed effects of limb darkening upon light and velocity curves of close binary systems. Z. KOPAL. *Circ. Harv. Coll. Obs.* (*No.* 454) 12 *pp.* (1949).

Theoretical expressions are established for light and velocity curves exhibited by the components of close binary systems, whose form is one of equilibrium under the instantaneous centrifugal and tidal forces, and whose apparent surface brightness varies from centre to limb in accordance with a generalized cosine law. A.

523.854.1

23. The density distribution in dark clouds and their masses. E. SCHOENBERG. *Z. Naturforsch.*, **4a**, 161–4 (*June*, 1949) *In German.*

Photometric studies of small isolated dark clouds show that density decreases in an undulatory manner from a sharp central maximum. Estimates of the masses of 31 clouds show that mass is approx. $\propto$ (diameter)^2. R. A. NEWING

523.854.1

24. The Milky Way at the junction of Gemini, Monoceros, and Orion. B. J. BOK, M. OLMSTED AND B. D. BOUTELLE. *Astrophys. J.*, **110**, 21–39 (*July*, 1949).

523.873

25. Anomalous spectra of stars of class *A*. M. E. WALTHER. *Astrophys. J.*, **110**, 67–72 (*July*, 1949).

523.874

26. The spectrum of *HD* 187399. P. W. MERRILL. *Astrophys. J.*, **110**, 59–62 (*July*, 1949).

523.874

27. Spectroscopic observations of *TW* Draconis. B. SMITH. *Astrophys. J.*, **110**, 63–4 (*July*, 1949).

523.877

28. The dynamical stability of white dwarfs. E. SAUVENIER-GOFFIN. *Ann. Astrophys.*, **12** (*No.* 1) 39–51 (1949) *In French.*

Radial oscillations of a degenerate configuration are investigated by the methods of Ledoux [Abstr. 2023 (1941), 2459 (1946)]. Calculations are made for Sirius *B*. A function Γ_d is introduced analogous to the adiabatic coefficient γ for a gas. Stability is found to increase as $\Gamma_d \rightarrow 4/3$, in contrast with the result for a gaseous configuration. R. A. NEWING

523.877

29. Transfer of radiation. D. H. MENZEL AND H. K. SEN. *Astrophys. J.*, **110**, 1–11 (*July*, 1949).

An operational method for solving the equation of radiative transfer in a "gray" plane-parallel atmosphere is given. Solutions are obtained according to various independent assumptions and the method is simple and capable of a high degree of accuracy. A comparison with Hopf's exact solution shows that the method gives consistent accuracy both near the boundary and in the deeper layers of the atmosphere, a feature not reached by any extant approximate method, with the possible exception of the Ambarzumian–Chandrasekhar method of solution by functional equation. The latter method has, however, so far been applied only to the emergent intensity at the boundary of the star. A.

523.877

30. Superthermic phenomena in stellar atmospheres. V. On emission lines at high kinetic temperature. R. N. THOMAS. *Astrophys. J.*, **110**, 12–16 (*July*, 1949).

The treatment of the radiation field of a high-kinetic-temp. chromosphere is continued. The conditions for emission lines to be formed and for an effective photosphere to be found in the chromosphere are investigated from a purely formal standpoint. For a quantitative investigation of the behaviour of the Balmer series, particularly with regard to the transient appearance of emission lines, a detailed investigation of inelastic collision cross-sections seems required. A.

523.877

31. On the possibility of fitting of convective cores of different compositions to a given envelope solution of the stellar equations. U. R. BURMAN. *Proc. Nat. Inst. Sci., India*, **15**, 269–75 (*Aug.*, 1949).

This possibility, allowing for a discontinuous change of composition across the interface, is examined. It is found that if a convective core fits on to an envelope solution for a composition uniform throughout the model, then another core of different size and composition, consistent with the same envelope solution, does not exist. This conclusion would therefore lend a uniqueness to the solution of the stellar problem of fit when obtained under suitable conditions. A.

523.877:539.153

32. Self-consistent field with exchange for Ca XIII. W. H. DAVIS. *Astrophys. J.*, **110**, 17–20 (*July*, 1949).

Since Ca XIII appears to be responsible for one of the coronal lines, it seemed desirable to find the Fock wave functions for the $3P$ ground state of this ion. These wave functions are tabulated. Two rough checks have been made with experiment. One check is the comparison of the Hartree energy parameters with observed energy difference, and the other is the comparison of the calculated and observed energy differences corresponding to the $3P_1$–$3P_2$ transition responsible for the coronal line. A.

527

33. Astronomy and navigation. D. H. SADLER. *Occ. Not. Roy. Astr. Soc.*, **2** (*No.* 13) 106–26 (1949).

An historical review of astronomical position finding in sea and air navigation, and a discussion of various nautical almanacs and the arrangements of their tables. Mentions as future possibilities the navigational use of artificial satellites.

PHYSICS 53

53.081

34. Symbols and nomenclature. C. DARWIN. *Nature, Lond.*, **164**, 262–4 (*Aug.* 13, 1949).

Questions of symbols in physics and chemistry, and also to some extent of units and terminology, discussed by the Symbols Committee of the Royal Society, the International Unions of Chemistry and Physics, and the Conference of Weights and Measures, are briefly considered. Reference is made to the adoption by the International Union of the Chemical, Physical and Faraday Societies' agreed list of symbols; the omission of symbols for elasticity; the popularity and unpopularity of various Roman and Greek letters for use as symbols for physical quantities; the pronunciation of the "joule," the unit of heat which is to replace the calorie; recommended changes in the temp. scale; no recommendation that the c.g.s. system of units should be abandoned by physicists; the proposal that temporarily the "international curie" = $3{\cdot}6\times10^{10}$ disintegrations a second; and several other minor points of notation and vocabulary useful as guidance to writers and authors. S. WEINTROUB

53.081.6 : 539.1

35. The atomic constants. F. KIRCHNER. *Phys. Bl.*, **5** (*No.* 7) 308–19 (1949) *In German.*

A short critical review. The following values are taken: electronic charge, $e = (4{\cdot}8020 \pm 0{\cdot}0020)\times 10^{-10}$ e.s.u.; Loschmidt's const. (number of atoms per mole), $N_L = (6{\cdot}0236 \pm 0{\cdot}0015)\times10^{23}$ mol^{-1} (chem. scale, O = 16), $= (6{\cdot}0252 \pm 0{\cdot}0015)\times10^{23}$ mol^{-1} (phys. scale $O^{16} = 16$); the Faraday, $F = (9\,648{\cdot}9 \pm 1)$ e.m.u. equiv.$^{-1}$ (chem. scale), $= (9\,651{\cdot}5 \pm 1)$ e.m.u. equiv.$^{-1}$ (phys. scale); specific charge of electron, $e/m_0 = (1{\cdot}7590 \pm 0{\cdot}0010)\times10^7$ e.m.u. gm^{-1}; electronic mass, $m_0 = (9{\cdot}106_6 \pm 0{\cdot}007)\times10^{-28}$ gm.; Planck's const., $h = (6{\cdot}623 \pm 0{\cdot}005)\times10^{-27}$ erg. sec.

A. O. STANESBY

FUNDAMENTALS 530.1

530.12

36. Forms of relativistic dynamics. P. A. M. DIRAC. *Rev. Mod. Phys.*, **21**, 392–9 (*July*, 1949).

For the purposes of atomic theory it is necessary to combine the restricted principle of relativity with the Hamiltonian formulation of dynamics. This combination leads to the appearance of 10 fundamental quantities for each dynamical system, namely the total energy, the total momentum and the 6-vector which has 3 components equal to the total angular momentum. The usual form of dynamics expresses everything in terms of dynamical variables at one instant of time, which results in specially simple expressions for 6 of these 10, namely the components of momentum and of angular momentum. There are other forms for relativistic dynamics in which others of the 10 are specially simple, corresponding to various subgroups of the inhomogeneous Lorentz group. These forms are investigated and applied to a system of particles in interaction and to the electromagnetic field. A.

530.12

37. On the space-time geometry of a moving rigid body. A. D. FOKKER. *Rev. Mod. Phys.*, **21**, 406–8 (*July*, 1949).

A simple argument is given to explain Herglotz's theorem that a rigid body has 3 degrees of freedom only. A new example of rigid motion is given. A.

530.12

38. Lagrangian multiplier and Riemannian spaces. C. LANCZOS. *Rev. Mod. Phys.*, **21**, 497–502 (*July*, 1949).

The Riemannian geometries, which are derivable from a quadratic action principle, are generated by a new mathematical approach, based on the method of the Lagrangian multiplier. This changes the 10 differential equations of fourth order for the g_{ik} to 24 differential equations of second order for a new field quantity. This field quantity is a tensor of third order, antisymmetric in one pair of indices, in remarkable analogy to the fundamental A-tensor of Einstein's theory of distant parallelism. The field equations are tied together by 13 identities. The basic structure of the field equations for infinitesimal fields is investigated and their relations to Einstein's theory of gravity and Einstein's theory of distant parallelism discussed. A.

530.12

39. A particle at rest in a static gravitational field. N. ROSEN. *Rev. Mod. Phys.*, **21**, 503–5 (*July*, 1949).

It is shown that, for a particle to be at rest in a static, axially symmetric gravitational field, the force on the particle must vanish. This result is then generalized to the case of an arbitrary static gravitational field. A.

530.12

40. Lorentz-type transformations as derived from performable rod and clock operations. H. E. IVES. *J. Opt. Soc. Amer.*, **39**, 757–61 (*Sept.*, 1949).

Transformations of the Lorentz-type are derived in terms of distance and time measurements made by rods and clocks subject to the Fitzgerald–Larmor–Lorentz contractions by their motion through the ether. These transformations contain terms involving the self-measured velocity of a transported setting clock which must be used to establish times at distant points. When the setting clock velocity is small the expressions approximate to the original Lorentz transformations. A.

530.12 : 523.11

Cosmological application of relativity. *See Abstr.* 8

530.12 : 531.51 : 536.7

41. Temperature equilibrium in a stationary gravitational field. H. A. BUCHDAHL. Letter in *Phys. Rev.*, **76**, 727–8 (*Aug.* 1, 1949).

Tolman and Ehrenfest's expression [Abstr. 1478 (1931)] $T_0(g_{44})^{\frac{1}{2}} = \text{const.}$ for the proper temp. T_0 in a static field ($g_{i4} \equiv 0$, $\partial g_{\mu\nu}/\partial x_4 \equiv 0$) is shown to remain valid for a stationary field ($g_{i4} \not\equiv 0$, $\partial g_{\mu\nu}/\partial x_4 \equiv 0$). R. A. NEWING

530.12 : 531.51 : 539.3

42. The problem of a rotating incompressible disc. G. L. CLARK. *Proc. Camb. Phil. Soc.*, **45** (*No.* 3) 405–10 (1949).

[See Abstr. 7320 (1949)]. The discussion is extended to the case when strain is no longer small. In the strained state the stress p is isotropic and such that $p = \alpha c^2\Delta/(1 + \Delta)$, Δ being the dilatation and α the density. There is again no change in the radius.

R. A. NEWING

530.12 : 536.7

43. On the thermodynamical equilibrium of fluids in gravitational fields. O. KLEIN. *Rev. Mod. Phys.*, **21**, 531–4 (*July*, 1949).

It is shown that the thermodynamical equilibrium condition for a fluid at rest in a static gravitational field is, apart from the Tolman condition $T(g_{44})^{\frac{1}{2}} =$ const., governed by the condition $\alpha(g_{44})^{\frac{1}{2}} =$ const., where α is the chemical potential of the fluid (including mass energy) regarded as a function of the space co-ordinates. This relation constitutes the relativistic generalization of the well-known Gibbs condition for the equilibrium in a gravitational field. A.

530.12 : 538.3

44. Kron's non-Riemannian electrodynamics. B. HOFFMANN. *Rev. Mod. Phys.*, **21**, 535–40 (*July*, 1949).

This paper discusses some aspects of Kron's tensor theories associated with the use of non-holonomic reference systems in the mathematical treatment of rotating electrical machines. The general theory is discussed in the first part, and is applied in the second part, by way of illustration, to a squirrel-cage induction motor. A.

530.12 : 538.3

Radiation from a uniformly accelerated charge. *See Abstr.* 386

530.145

45. Transition probabilities of quantum-mechanical oscillators calculated by the phase-space method. M. S. BARTLETT AND J. E. MOYAL. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 4) 540–53 (1949).

The "phase-space" method in quantum theory is used to derive exact expressions for the transition probabilities of a perturbed oscillator. Comparison with the approximate results obtained by perturbation methods shows that the latter must be multiplied by an exponential factor $\exp(-\varepsilon/\hbar\omega)$, where ε is the non-fluctuating part of the work done by the perturbing forces; as long as ε is small, $\exp(-\varepsilon/\hbar\omega) \sim 1$ and only dipole transitions have an appreciable probability. As the perturbation energy increases, however, this is no longer true, and multipole transitions become progressively more probable, the most probable ones being those for which the change in energy $\simeq$ the work done by the perturbing forces. A.

530.145

46. Localized states for elementary systems. T. D. NEWTON AND E. P. WIGNER. *Rev. Mod. Phys.*, **21**, 400–6 (*July*, 1949).

It is attempted to formulate the properties of localized states on the basis of natural invariance requirements. Chief of these is that a state, localized at a certain point, becomes, after a translation, orthogonal to all the undisplaced states localized at that point. It is found that the required properties uniquely define the set of localized states for elementary systems of non-zero mass and arbitrary spin. The localized functions belong to a continuous spectrum of an operator which it is natural to call the position operator. This operator has automatically the property of preserving the positive energy character of the wave function to which it is applied (and it should be applied only to such wave functions). It is believed that the development here presented may have applications in the theory of elementary particles and of the collision matrix. A.

530.145

47. On the invariant regularization in relativistic quantum theory. W. PAULI and F. VILLARS. *Rev. Mod. Phys.*, **21**, 434–44 (*July*, 1949).

The formal method of regularization of mathematical expressions of sums of products of different types of δ-functions is first applied to the example of vacuum polarization. It is emphasized that only a regularization of the whole expression without factorization leads to gauge invariant results. It is further shown, that for the regularization of the expression for the magnetic moment of the electron, a single auxiliary mass is sufficient, provided that different functions of the same particle (e.g. the photon functions $\bar{D}$ and $D^{(1)}$) are regularized in the same way and that the regularization of products of two electron functions is never factorized. The result is then the same as that of using Schwinger's method of introducing suitable parameters as new integration variables in the argument of δ-functions, without using any auxiliary masses. A.

530.145

48. On the radius of the elementary particle. H. YUKAWA. Letter in *Phys. Rev.*, **76**, 300–1 (*July* 15, 1949).

Simple quantized field theories are constructed where the fields are no longer functions of space and time alone, and the equations satisfy the reciprocity conditions. They can be regarded as describing particles of finite mass and extension. This is done for scalar and Dirac particles. G. J. KYNCH

530.145 : 530.12

49. Non-linear field theories. II. Canonical equations and quantization. P. G. BERGMANN AND J. H. M. BRUNINGS. *Rev. Mod. Phys.*, **21**, 480–7 (*July*, 1949).

[See Abstr. 2336 (1949)]. A covariant field theory of the general type of the theory of relativity is brought into the canonical form and then quantized. Particles are assumed to be represented as singularities of the field. Primarily, two difficulties had to be overcome. First, the variational integral should be extended only over that space-time domain which is free of singularities. Since the location of the singular world lines cannot be known until after the integration of the field equations has been completed, a second set of co-ordinates has been introduced—called "parameters" in this paper—which will serve as variables of integration and in terms of which the motions of the particles can be arbitrarily prescribed.

The second difficulty arises in that the expressions for the canonical momentum densities cannot be solved with respect to the partial time derivatives of the field variables; this circumstance precludes the construction of the Hamiltonian by the usual methods. Nevertheless, it is shown that a Hamiltonian exists, though it is not uniquely determined by the Lagrangian; this Hamiltonian contains an arbitrary linear combination of the 8 algebraic relationships that exist between the canonical variables at each world point. The canonical field equations have the usual form. They are covariant if the choice of Hamiltonian is left open. The 8 algebraic constraints on the canonical variables at each point are all integrals of the field equations. So are the Poisson brackets between the canonical variables (at the same time). When this system of equations and constraints is quantized, the property of general covariance can be used to carry out a proof of the covariance of the whole theory, including the commutation relations, that requires none of the computational effort usually required in theories that are merely Lorentz invariant. Once the system of equations has been completed, it turns out that the covariance goes much farther than was required originally. Because of the introduction of the parameters, the ordinary co-ordinates of space-time turn formally, at least, into dynamical variables, and the usual canonical transformations, with respect to which the theory is covariant, transform the co-ordinates, the original field variables, and the canonical conjugates of both together. The canonical conjugates of the co-ordinates are the expressions ordinarily interpreted as energy and momentum densities. The physical significance of these canonical transformations, which cause the world points to lose their identities, is not yet understood. A.

530.145 : 537.122

50. The level shift and the anomalous magnetic moment of the electron. Y. NAMBU. *Progr. Theor. Phys.*, **4**, 82–94 (*Jan.–March*, 1949).

530.145 : 537.122

51. On the spin and the structure of the electron. F. BOPP. *Z. angew. Phys.*, **1**, 387–90 (*May*, 1949) *In German.*

The theory discussed previously [Abstr. 1698, 1699 (1949)] is presented in a different form to emphasize the role of the dipole moment and to show a simple quantization giving particle equations of arbitrary spin [Abstr. 3054 (1947)]. G. J. KYNCH

530.145 : 538.22

A note on the quantum theory of ferromagnetic resonance. *See Abstr.* 373

530.145 : 538.3

52. On the elimination of the auxiliary condition in the quantum electrodynamics. I. S. HAYAKAWA, Y. MIYAMOTO AND S. TOMONAGA. *J. Phys. Soc. Japan*, **2**, 172–83 (*Nov.–Dec.*, 1947).

A relativistic generalization is developed of the separation of the longitudinal and transverse fields in the many-time theory of Dirac, Fock and Podolsky, using arbitrary 4-vectors. It is shown that the generalized longitudinal field reduces to the ordinary one in a new Lorentz frame of reference moving with an arbitrary velocity u which can be a function of the momentum vector k. Instead of a Coulomb interaction the longitudinal component leads to a Lenard–Wiechert potential when the auxiliary condition is eliminated. G. J. KYNCH

530.145 : 538.3

53. On the elimination of the auxiliary condition in the quantum electrodynamics. II. S. HAYAKAWA, Y. MIYAMOTO AND S. TOMONAGA. *J. Phys. Soc. Japan*, **2**, 199–204 (*Nov.–Dec.*, 1947).

The separation described in I [previous abstract] is applied first to the self-energy problem. Choosing for u the velocity of an electron results in a complete separation of its classical and quantum (vacuum fluctuation) self-energies in an invariant manner. The radiation field of an electron is next examined and the results of Bloch and Nordsieck reproduced. In particular, the longitudinal component now corresponds to the self-field of the electron in so far as quantum fluctuations can be neglected. G. J. KYNCH

530.145 : 538.3

54. On the treatment of quantum electrodynamics without eliminating the longitudinal field. NING HU. *Phys. Rev.*, **76**, 391–6 (*Aug.* 1, 1949).

It is shown that the supplementary condition in quantum electrodynamics can be satisfied identically without eliminating the longitudinal components of the electromagnetic field, provided certain rules on the summation over the polarizations of the photons are observed. The result is shown to be identical with that obtained by the usual method in which the longitudinal field is eliminated. This simplifies greatly the calculation since no separate treatment of longitudinal and transverse fields is needed. A.

530.145 : 539.18

55. Exchange of charge between elementary particles. J. DE BOER. *Ned. T. Natuurkde*, **15**, 169–75 (*July*, 1949) *In Dutch.*

In an attempt to correlate various types of interaction between elementary particles it is shown that the physical constant giving a measure of the probability of such processes of interaction is very nearly the same in the 3 cases: (1) β-radioactivity, interaction between neutrons and nucleons, electrons and neutrinos ("leptons"); (2) μ-meson decay, between μ-mesons and leptons; (3) μ-meson absorption, between μ-mesons and nucleons.

E. P. WOHLFARTH

530.145.6

56. On the postulational basis of the theory of elementary particles. H. J. BHABHA. *Rev. Mod. Phys.*, **21**, 451–62 (*July*, 1949).

A set of postulates is formulated which leads to the relativistic wave equations of present quantum mechanics. The mathematical difference between the usual non-linear interaction terms and terms which introduce essential non-linearities in the equations is discussed. It is proved that every particle must possess an anti-particle unless at least one of the basic postulates is discarded. The connection between the rest mass of the particle, the minimal equation of the α-matrices, and the general commutation relations of the α-matrices is derived and discussed. It is proved that for a particle of spin $\frac{1}{2}$ there is only one possible wave equation, while for a particle of spin 1 there

are others besides the usual scalar and vector equations. One such example is given. A.

530.145.6

57. Wave equation of a particle of spin ½ in the field of a particle of spin 1 and a generalization of the gauge transformation of the first kind. B. KWAL. *C.R. Acad. Sci., Paris*, **228**, 980–1 (*March* 21, 1949) *In French.*

The ideas proposed by the author in Abstr. 5257 (1949) are here extended, and it is shown that they may give an explanation of the inaccuracy of the Dirac equation when applied to the fine structure of the hydrogen lines. P. M. DAVIDSON

530.145.6

58. A special method for solving the Dirac equations. A. H. TAUB. *Rev. Mod. Phys.*, **21**, 388–92 (*July*, 1949).

Exact solns. for an electron in an external field of an arbitrary plane wave are obtained by transforming plane wave solns. for a free electron by variable Lorentz matrices. These matrices are those which occur in the discussion of the classical orbits. An example shows that this method, which applies classically, may fail for the Dirac equations when the external field is a constant one. A.

530.145.6

59. On the decomposition of tensors by contraction. G. RACAH. *Rev. Mod. Phys.*, **21**, 494–6 (*July*, 1949).

The decomposition of tensors into irreducible representations of the orthogonal groups is calculated for 3 and 4 dimensions. The connection is shown with the problem of the allowed values of ordinary and isotopic spin for a given symmetry of the spatial eigenfunction of a nuclear system. A.

530.145.6

60. Two-component wave equations. C. W. KILMISTER. Letter in *Phys. Rev.*, **76**, 568 (*Aug.* 15, 1949).

By a modification of Eddington's derivation of Dirac's equation for the electron, equations similar to Dirac's are obtained which admit a 2-dimensional representation in a special case. This representation is related to that given by Jehle [Abstr. 5259 (1949)]. G. J. KYNCH

530.145.6 : 537.132

The theory of positrons. *See Abstr.* 243

530.145.6 : 538.3

61. Remarks on the problem of the vacuum polarization and the photon self-energy. R. JOST AND J. RAYSKI. *Helv. Phys. Acta*, **22** (*No.* 4) 457–66 (1949).

The interaction of the e.m. field with any number of charged scalar and spinor fields is considered. The gauge invariance of the vacuum polarization current and a zero value for the photon self-energy are achieved by imposing two conditions on the numbers and masses of the fields separately, similar in type to those given by the regularization procedure. There remains the difficulty of charge renormalization in an external field. G. J. KYNCH

530.145.6 : 539.18

62. Theory of particles of spin 2. M. YA. SHIROBOKOV. *J. Exp. Theor. Phys., USSR*, **19**, 481–6 (*June*, 1949) *In Russian.*

It is shown that a particle of spin 2 is not possessed of a kinematic electromagnetic dipole moment, yet of quadrupole and octupole moments active in radiation and not vanishing in the relativistic limiting case. Calculations show that the effective cross-section in optical scattering of the spin 2 particle grows indefinitely and at an extraordinary rate, as the frequency of the scattered light rises. As the optical scattering on elementary particles depends essentially on the character of the electromagnetic moment of the scatterer, this result points to the fact that the spin 2 particle possesses e.m. moments of order > 2. [As surmised by Heitler and Ma, Abstr. 140 (1941)]. The calculation is based on the relativistic wave equations of the spin 2 particle in an external magnetic field, as given by Fierz and Pauli [Abstr. 44 (1940)], which show the absence of a kinematic dipole moment, whereas the detection of the true character of the moments uses Ginsburg's method [Abstr. 2145 (1945)] of investigation of the directed radiation of a particle uniformly moving through a medium (Cherenkov effect). B. F. KRAUS

530.145.61

63. On the connection between phase shifts and scattering potential. V. BARGMANN. *Rev. Mod. Phys.*, **21**, 488–93 (*July*, 1949).

Construction and discussion of phase equivalent potentials, i.e. of potentials which give equal phase shifts for S-waves. In particular, it is shown that the phase shifts do not determine the energy of bound states, and that there exist continuous families of phase equivalent potentials. A.

530.145.61

64. Separation of the variables in the one-particle Schroedinger equation in 3-space. L. P. EISENHART. *Proc. Nat. Acad. Sci., Wash.*, **35**, 412–18 (*July*, 1949).

A continuation of previous work [Abstr. 5965 (1949)]. Those orthogonal co-ordinate systems for which the equation is separable are characterized. L. S. GODDARD

530.145.63

65. The analytic behaviour of Heisenberg's S matrix. R. J. EDEN. *Proc. Roy. Soc. A*, **199**, 256–71 (*Oct.* 25, 1949).

The S-matrix is considered for a system made up of an elementary particle being scattered on a fixed centre which has internal excited states. At threshold energy values for inelastic scattering, the S-matrix undergoes abrupt changes of behaviour. A method of representing these as non-analytic changes in the matrix elements as functions of the total energy is suggested, and some of the implications investigated. It is shown that it may still be possible for the eigenvalues of S to be analytic functions of energy at the threshold values. The usual perturbation theory of quantum mechanics is used to consider a resonance scattering system of this type, and it is shown that the non-analytic changes in the matrix elements correspond to a non-analytic change in the unitary condition of S. When the incident particle is a photon, the excited states of the scatterer are necessarily unstable, and the S-matrix elements have singularities in the complex energy plane which correspond to these unstable levels. These singular points show clearly the connection between the line widths for resonance scattering and Einstein's coefficients for spontaneous emission. It is shown

that relative intensities of spectral lines may be obtained from the *S*-matrix for scattering of light on an atom. A.

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.19

66. Further deductions from the ℵ-theorem. H. EINBINDER. *Phys. Rev.*, **76**, 410–12 (*Aug.* 1, 1949).

For an ideal statistical gas, where $PV = sE$, all thermodynamic functions can be derived from $G(V, T)$, i.e. $A(V, T)$ is given by a suitable integration over $G(V, T)$. Since $G = N\mu$, the normalization constant, $\mu(V, T)$, of the distribution function is sufficient to provide a complete thermodynamic description of such a system. With the aid of the ℵ-theorem it is shown that there is a sharp physical distinction between the degenerate and non-degenerate Bose–Einstein gases; to any given density there corresponds a transition temp. between them. The method developed is applied to the general (relativistic and non-relativistic) non-degenerate quantum and degenerate Fermi–Dirac gases. A.

531.31

67. Physical families in conservative fields of force. E. KASNER AND J. DE CICCO. *Proc. Nat. Acad. Sci., Wash.*, **49**, 419–22 (*July*, 1949).

A system of ∞^3 curves in a field of force is considered, whose curves are such that a constrained motion along them is possible. In this motion the pressure is proportional to the normal component of the force vector. Differential equations satisfied by these curves are set up and the geometry of the system of curves is studied. L. S. GODDARD

531.311

68. Evaluation of impulse measurement by means of the Laplace transformation. G. HEINRICH. *Öst. Ingen. Arch.*, **3** (*No.* 4) 327–36 (1949) *In German.*

531.4

69. What about friction? F. PALMER. *Amer. J. Phys.*, **17**, 327–35 (*Sept.*, 1949).

MECHANICAL MEASUREMENTS 531.7

531.77

70. Direct reading device for measuring the angular velocity of ultracentrifuges. A. BARONE. *R.C. Ist. Super. Sanità*, **11** (*Pt* 6) 1489–95 (1948) *In Italian.*

531.787

71. Establishment of a pressure scale and experimental realization up to 20 000 atmospheres. H. EBERT. *Z. angew. Phys.*, **1**, 331–40 (*March*, 1949) *In German.*

Describes various types of manometer in general use, with the necessary experimental precautions and corrections. Suggests Hg manometer up to 25 atm., piston manometer up to 5 000 atm., resistance manometer up to 12 000 atm. and hydraulic manometer up to 20 000 atm. N. CORCORAN

MECHANICS OF FLUIDS 532

532.13 : 536.655

72. The correlation between viscosity and energy of vaporization. E. BRUNNER. Letter in *J. Chem. Phys.*, **17**, 346–7 (*March*, 1949).

An equation proposed by Glasstone Laidler and Eyring (*Theory of Rate Processes*) connecting viscosity and energy of vaporization suggests that a quantum effect is involved. The equation is examined and an alternative of similar form suggested. The two equations are compared for 67 liquids and the R.M.S. deviations found to be of the same order. It is claimed that the derivation of the alternative is more nearly understandable and satisfactory as it does not suggest that viscosity is a quantum phenomenon. F. E. HOARE

532.133

73. Viscosity of deuterium oxide and water in the range 5° to 125°C. R. C. HARDY AND R. L. COTTINGTON. *J. Res. Nat. Bur. Stand., Wash.*, **42**, 573–8 (*June*, 1949).

Measurements of the absolute viscosity of D_2O of 99·5% purity and of H_2O were made over the range 5° to 125°C. It is estimated that these determinations are accurate within 0·1% in relation to the value 1·0050 centipoise for the viscosity of water at 20°C. The work also included determinations of the density of D_2O over the range 90° to 125°C. Values for the viscosity and density of 100% D_2O were obtained by linear extrapolations. The ratio of the viscosity of D_2O to that of H_2O at the same temp. was found to be 1·3052 at 5°C. This ratio decreased at a diminishing rate with increase in temp. to a value of 1·1456 at 125°C. A.

532.133

74. Viscosity of molten naphthalene. W. J. MORRIS AND R. SCHNURMAN. Letter in *Research, Lond.*, **2**, 394 (*Aug.*, 1949).

532.133 : 534.221

75. Erratum: The second viscosity of liquids. L. N. LIEBERMANN. *Phys. Rev.*, **76**, 440 (*Aug.* 1, 1949). See Abstr. 4514 (1949).

532.5

76. Fields from fluid flow mappers. A. D. MOORE. *J. Appl. Phys.*, **20**, 790–804 (*Aug.*, 1949).

Fluid flow within the streamline (viscous) range, made visible by appropriate means, may be made to simulate fields occurring in electrostatic, magnetic, electric current, heat flow, chemical diffusion and other situations. Simple, reliable and inexpensive techniques for setting up the desired fluid flow situations have been worked out and are described fully. 2-dimensional fields with one, several, or many non-distributed sources (or sinks) may usually be made up and operated with ease. Techniques for the simulation of certain 3-dimensional fields with axes of symmetry have also been developed. Through the invention of a "sandbed" feature, the fluid flow

method has been greatly extended: fields due to distributed sources can be simulated, not only outside the sources, but inside them as well. Numerous photographs of fluid mappers in operation, illustrating all of the foregoing types of cases, are included. A.

532.5

77. The normal-stress coefficient in solutions of macro-molecules. R. S. RIVLIN. *Trans. Faraday Soc.*, **45**, 739–48 (*June*, 1949).

In a previous paper [Abstr. 2028 (1948)] it has been shown that if the stress components at a point of a fluid depend only on the state of flow in a small element about that point at the instant considered, then in general, 2 physical parameters are required to define completely the flow properties of the fluid. One of these is the viscosity and the other will be called the normal-stress coefficient. Each of these may or may not be dependent on the state of flow. In the present paper a method similar to that adopted by Kramers [Abstr. 2785 (1948)] to calculate the intrinsic viscosity of a high-polymer solution has been employed to calculate its normal-stress coeff. It is shown that appreciable values of the normal-stress coeff. may be expected in concentrated solutions and that its non-vanishing results from the orientation of the molecules in the flowing solution. A.

532.51 : 550.34

78. Impulsive hydrodynamics of fluid inside a cylindrical tank and of fluid surrounding a cylindrical pier. L. S. JACOBSEN. *Bull. Seism. Soc. Amer.*, **39**, 189–204 (*July*, 1949).

Effective hydrodynamic masses and mass moments have been calculated for the fluid when the base of the tank or pier experiences an impulsive, horizontal translation. The impulsive velocities set up in the tank have been studied with a view to extending the analysis beyond the impulsive time interval. Application of the analysis to a specific example has been made. A.

532.511

79. A new conservation-theorem of hydrodynamics. H. ERTEL AND C.-G. ROSSBY. *Geofis. Pura Appl.*, **14**, 189–93 (*April–June*, 1949) *In English.*

Let $\mathbf{v}$ be the absolute velocity and $\sigma = \sigma(p)$ the specific volume of a barotropic fluid. The theorem is that $D\{\sigma \operatorname{curl} \mathbf{v}(\mathbf{v} - \operatorname{grad} W)\}/Dt = 0$, where W is the action and differentiation follows the motion of the fluid. Two proofs are given, one from Lagrange's equations, the other from Euler's equations.

L. S. GODDARD

532.525 : 536.24

80. Transfer of heat and matter in the turbulent mixing zone of an axially symmetrical jet. J. O. HINZE AND B. G. VAN DER HEGGE ZIJNEN. *Appl. Sci. Res.*, **A 1** (*Nos* 5–6) 435–61 (1949).

Describes results of measurements concerning the radial and axial distribution of time-mean values of velocity, temp. and gas concentration in a turbulent jet issuing from a round orifice into quiescent ambient air. The results show that the rates of spreading of heat and matter are mutually equal but > that of velocity. A constant ratio between the coeff. of transfer of heat or matter and the coeff. of shearing stress does not seem to exist. The results have been subjected to a theoretical analysis. The theory based on a constant coeff. of shearing stress across the jet gives the best agreement with measured radial velocity-distribution in a central zone of the jet. The theory based on a constant coeff. of transfer of heat or matter gives results that cover the experimental results reasonably well, again for the central zone. A better agreement, however, is obtained if the coeff. of transfer of heat or matter is assumed to contain not only a constant part but also a part $\propto$ the local velocity. This assumption is in agreement with the variable ratio between this coeff. and that of shearing stress. A.

532.59 : 538.69

81. Experimental demonstration of magneto-hydrodynamic waves. S. LUNDQUIST. Letter in *Nature, Lond.*, **164**, 145–6 (*July* 23, 1949).

Details are given of an experiment demonstrating the existence of magneto-hydrodynamic waves, first suggested by Alfvén [Abstr. 76 (1943)]. Satisfactory agreement with theoretical estimates of the magnitude of the phenomenon is noted. W. J. G. BEYNON

CAPILLARITY 532.6

532.6 : 548.7

82. The forces between floating bubbles and a quantitative study of the Bragg "bubble model" of a crystal. W. M. LOMER. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 4) 660–73 (1949).

An attempt to derive the forces acting in bubble rafts and to use them for a description of the mechanical properties of these rafts. The essence of the paper is a treatment of the repulsive forces arising under uniaxial compression of a bubble. Expressions are deduced for Young's modulus and Poisson's ratio. A brief check against experiment provides reasonable agreement in the case of small bubbles. The reasons for divergence in the case of large bubbles are noted. G. O. BAINES

532.69

83. Laws of atomization of liquids by centrifugal nozzles. I. I. NOVIKOV. *J. Tech. Phys., USSR*, **18**, 345–54 (*March*, 1948) *In Russian.*

A hydrodynamic theory of the process of atomization is presented for liquids, the viscosity of which may be neglected and the mechanism of the disintegration of the liquid film forming at the exit orifice of the nozzle into drops is discussed. Formulae are given for the mean diameter of the drops so formed. B. F. KRAUS

532.69 : 551.578.1

84. The terminal velocity of fall for water droplets in stagnant air. R. GUNN AND G. D. KINZER. *J. Met.*, **6**, 243–8 (*Aug.*, 1949).

The terminal velocities for distilled water droplets falling through stagnant air are accurately determined. More than 1 500 droplets of mass from 0·2 to 100 000 μg, embracing droplets so small that Stokes's law is obeyed up to and including droplets so large that they are mechanically unstable, were measured

by a new method employing electronic techniques. An apparatus for the production of electrically charged artificial water droplets at a controllable rate is described. The overall accuracy of the mass–terminal-velocity measurements is better than 0·7%. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.72

85. On thermal diffusion in the water-alcohol system. I. PRIGOGINE AND R. BUESS. Letter in *Physica*, **15**, 465–6 (*July*, 1949) *In French.*

Gorter and others have applied the results of de Groot to a study of the thermal diffusion of the system water–alcohol in concentrated solution [Abstr. 2799 (1946)], whereas the theory is applicable only to dilute solutions. For concentrated solutions the linear approximation of Jones and Furry [Abstr. 1273 (1947)] is applicable; this is legitimate in the measurements of Gorter. The approximation is developed analogously to that of de Groot and the effect on Gorter's results for the coeff. of thermal diffusion shown graphically. F. E. HOARE

MECHANICS OF GASES 533

533.15.096

86. Temperature effects in the diffusion of real gases. L. MILLER. *Z. Naturforsch.*, **4a**, 262–5 (*July*, 1949) *In German.*

The diffusion thermo-effect of pure H/N in a closed cylindrical diffusion vessel has been investigated and the variation with time of the temp. distribution in the gases determined. The latter is shown graphically. There are indications of a negative heat of mixing in accordance with thermodynamics. A brief thermodynamical derivation is given. The measured max. temp. deviations from room temp. for a series of other gas pairs are tabulated. The temp. distribution changes in the diffusion of H from an open cylinder into free space was also investigated. The forms of apparatus used in both the closed and open cylinder experiments are fully described. S. WEINTROUB

533.21

87. Isotherms of argon between 0°C and 150°C and pressures up to 2 900 atmospheres. A. MICHELS, HUB. WIJKER AND HK WIJKER. *Physica*, **15**, 627–33 (*Aug.*, 1949) *In English.*

The results are given of compressibility isotherms of A at 7 temps. from 0° to 150°C and pressures up to 2 900 atmos. A.

533.5 : 531.788.7

88. Several improvements on the "Philip's gauge." C. HAYASHI, K. HASHIMOTO, K. KANEKI, K. OKAMOTO AND R. SAGANE. *Rev. Sci. Instrum.*, **20**, 524–6 (*July*, 1949).

Relate to (1) use of gauge in the pressure region of 10^{-6} mm Hg, (2) use of cylindrical electrode to increase the current for a given vacuum, (3) use of gauge to measure pressures of 0·1 mm Hg and higher, (4) use of gauge as a type of safety relay. The constructional and electrical modifications required are described and 5 figures show the corresponding results. G. WITTENBERG

533.5 : 531.788.1

89. A precision vacuum gauge. G. C. FRYBURG AND J. H. SIMONS. *Rev. Sci. Instrum.*, **20**, 541–8 (*Aug.*, 1949).

A pressure measuring device of the general type first described by Knudsen has been constructed for obtaining precision measurements of gaseous pressures in the range from 1×10^{-5} to 10^{-3} mm of Hg. The instrument has been calibrated, with the aid of a McLeod gauge, in N, H, O, CH_4, ethylene, normal-butane and *iso*-butane. The mechanical precision of the instrument seems to be better than $\pm$ 0·5% and the accuracy of the above calibrations is probably of the order of $\pm$ 1%. Calibration curves for the above gases have been treated analytically and equations for the different gases have been discussed. An empirical method of calibration has been described for calibrating the instrument in condensible gases whose pressures cannot be measured in a McLeod gauge. A.

533.56

90. Ultimate vacua of diffusion pumps. G. W. SEARS. Note in *Rev. Sci. Instrum.*, **20**, 458–9 (*June*, 1949).

The paper is concerned with the behaviour of the pumping speed curve in the low pressure cut-off region. Expressions are derived for true pumping speed and for effective speed allowing for evolution of gases, the latter being used to construct a pumping speed curve which is plotted along an experimental curve. Outgassing of pumping systems, decomposition of various pumping fluids, and limiting pressures are discussed. G. WITTENBERG

533.6.011

91. On steady, laminar, round jets in compressible viscous gases far behind the mouth. M. Z. KRZYWOBLOCKI. *Öst. Ingen. Arch.*, **3** (*No.* 4) 373–83 (1949) *In German.*

The work represents an expansion of Schlichting's solution for the non-compressible case, whereby the effects of compressibility are taken care of, step by step, by series-representation. Since an asymptotic representation for the development of the co-ordinates in the direction of the jet axis is being used, the solutions obtained can only be considered valid at a considerable distance from the orifice. A.

533.6.011.5 : 534.222.2

92. The formation and growth of shock waves in the one-dimensional motion of a gas. A. F. PILLOW. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 4) 558–86 (1949).

Theoretical. The simple classical theory of compressible fluid flow, neglecting viscosity, thermal conductivity, and dynamical terms in the equation of state, is in some cases inadequate as it predicts zones of infinite acceleration, beyond which the solution is often multi-valued. It is shown that the inclusion of terms to take account of these factors

affects the solution to a major extent only in certain special regions of the field of flow, and that elsewhere the manipulative advantages of the simple theory can be retained. As viscosity and thermal conductivity tend towards zero the special regions do not disappear, but decrease in thickness to form discontinuities which may be identified with shock waves. The formation of shock waves is discussed from this point of view, the discussion being illustrated by a detailed examination of unidimensional flow in a tube bounded at one end by a moving piston. Special cases treated are (i) a uniformly accelerated piston, (ii) a piston moving with a constant velocity.

A. SCHOFIELD

533.6.011.5 : 535.412

Identification of fringes in interferograms for gaseous flow. *See Abstr.* 199

533.6.08 : 536.55

93. A method for the instantaneous measurement of velocity and temperature in high speed air flow. D. G. MARLOW, C. R. NISEWANGER AND W. M. CADY. *J. Appl. Phys.*, **20**, 771–6 (*Aug.*, 1949).

A beam of ultrasonic sound waves is projected across an air stream the velocity and temp. of which are required. From the known ultrasonic frequency and the measured wavelength, the temp. may be determined; and from the slope of the beam boundary, an approximate Mach number may be obtained. The method is applicable to steady-flow problems as in wind tunnels or to transient-flow problems such as the study of shock waves. A.

533.6.08 : 621.317.39

94. Measuring air velocity with a thermo-pile. C. E. HASTINGS. *Elect. Engng, N.Y.*, **68**, 528 (*July*, 1949).

A small thermopile is heated from the mains via a constant voltage transformer and is placed in the air stream. The resultant induced voltage is $\propto$ temp. difference and thence to air flow, with max. voltage at zero air flow, as is indicated by a millivoltmeter. A recording potentiometer may be employed if desired. For high accuracy over a wide velocity range a second thermopile is arranged in opposition and shielded from air currents. Velocities down to 5 ft/min are measurable, with applications to air conditioning, wind flow, etc. E. H. W. BANNER (R)

VIBRATIONS . ACOUSTICS 534

534.213

95. Characteristic vibrations of glass cylinders. L. BERGMANN. *Z. Phys.*, **125** (*Nos* 7–10) 405–17 (1949) *In German.*

The elastic vibrations of cylinders of optical glass have been observed by both plane and circularly polarized light. The polarized light was projected axially through the cylinder under test which had a matt curved surface and rested on a piezoelectric quartz crystal forming part of an oscillatory circuit operating within the range 500–1 600 kc/s. The photoelastic patterns obtained showed pure radial elastic vibration in many cases, and the radii of the nodes of these vibrations were in good agreement with those deduced theoretically. A. C. WHIFFIN

534.22

96. Velocity of sound in liquid nitrogen. A. VAN ITTERBEEK, A. DE BOCK AND L. VERHAEGEN. *Physica*, **15**, 624–6 (*Aug.*, 1949) *In English.*

534.22 : 536.55

Temperature measurement by sonic means. *See Abstr.* 620

534.222.2

97. The density field in Mach reflection of shock waves. W. BLEAKNEY, C. H. FLETCHER AND D. K. WEIMER. Letter in *Phys. Rev.*, **76**, 323–4 (*July* 15, 1949).

The reflection of a plane shock-wave by a rigid plane wall placed obliquely to its direction of propagation was examined by means of a Mach–Zehnder interferometer in "single-fringe" adjustment. The point of intersection of the incident shock with the reflected shock is some distance away from the wall, to which it is joined by a "Mach-bridge" shock. The Mach-bridge shock is followed near the wall by a rarefaction wave. Along a streamline behind the reflected shock, but outside the slip-stream of the Mach shock, the density rises to a max. and falls again; this effect is most pronounced with weak shocks at high angles of incidence. A. SCHOFIELD

534.321.9

98. Propagation of ultrasonic waves in a rigid rod. T. HÜTER. *Z. angew. Phys.*, **1**, 275–89 (*Jan.*, 1949) *In German.*

A study of the problem of applying ultrasonic energy to inaccessible sites, e.g. as in medical treatment. The frequencies usually employed lie within the range 300–1 000 kc/s, the rod diameters are 0·8–2·0 cm, and their length 10–20 cm. Calculations are made of the dispersion occurring with various diameter/wavelength ratios, and measurements are made of the radial waves along typical rods. In some cases comparison between calculated and measured values of dispersion was possible and agreement was obtained to within 10%. Measurements were also made of the attenuation at various frequencies of a quartz plate, Al-rod, water combination. A relation was found between the energy transmitted and the inverse of the cylinder diameter. The problem of energy concentration was studied by Schlieren photographs of waves propagated through a funnel under water. A. C. WHIFFIN

534.321.9

99. Ultrasonic absorption in water in the region of 1 Mc/s. C. E. MULDERS. *Nature, Lond.*, **164**, 347–8 (*Aug.* 27, 1949).

The absorption of ultrasonic waves in water at 25° C was determined by measuring the reverberation time, which was approximately 10 msec. The water was contained in a cylindrical Al vessel, and the measured damping was produced not only by absorption in the liquid, but also by radiation into the air, friction along the walls, etc. Theoretical estimates were made of these various effects, and it was found that the only important loss was that caused by friction along the walls and bottom of the vessel. Tests were

made at 750, 1 010 and 1 500 kc/s, using vessels of 28 cm dia. and 10 cm high, and absorption coeff./freq.^{2} was found constant. A. C. WHIFFIN

534.321.9 : 537.228.2

100. Ultrasonics and electrostriction. H. FALKENHAGEN. *Z. angew. Phys.*, **1**, 304–6 (*March*, 1949) *In German.*

The possibility of using the electrostrictive effect for producing ultrasonic waves in solids, liquids and gases is discussed. The main advantage is that a wide range of frequency extending up to at least 5 000 Mc/s is possible. Apparatus is described for obtaining ultrasonic waves of about 0·12 mm wavelength in xylol. H. J. H. STARKS

534.321.9 : 539.61

Evaluation of adhesion by ultrasonic vibrations. *See Abstr.* 558

534.321.9 : 541.182.6

Dispersion of clay suspensions by ultrasonics. *See Abstr.* 572

534.321.9 : 541.183.5

Influence of ultrasonic radiation on adsorption of fatty acids. *See Abstr.* 573

534.321.9 : 615.85

The mechanical and biological effects of ultrasonics. *See Abstr.* 640

534.321.9 : 621.395.625

101. Improved ultrasonic delay lines. F. A. METZ, JR. AND W. M. A. ANDERSEN. *Electronics*, **22**, 96–100 (*July*, 1949).

Attempts to replace liquids as transmitting media by solids are described, the object being to develop lines with a delay $\geqslant 3$ msec, operating at a frequency $\geqslant 10$ Mc/s, and having a bandwidth > 2 Mc/s. The good transmitting qualities of fused quartz are off-set by size limitation and machining difficulties. Certain Mg alloys come next, giving, for example, 40 db attenuation for a delay of 400 μsec with perhaps a 6 db improvement on heat treatment. Folding of the line improves compactness, but makes heat treatment essential, with resulting variation of performance between samples. Continued drop forging, which produces a larger and more orderly grain structure, can effect a 30 db improvement in an initially poor material. Temp. coeffs. are generally slightly $<$ that of Hg. The shear mode of vibration is the best, giving rise to a polarized wave and a gain in s./n. ratio of ~ 5 db over the compressional mode. The normal bandwidth is < 1 Mc/s, but this is somewhat improved by substituting a $NH_4H_2PO_4$ crystal for quartz and still more by pressure mounting the crystal. Best results are obtained by dividing the output electrode of the output crystal, tuning and damping each division separately, and mixing the outputs electronically. A band-spreading effect results and the overall bandwidth of the delay line may be made to approach its acoustical response.

H. G. M. SPRATT

534.62

102. Principles of construction of a sound-proof room. M. MILOSEVIC. *Rev. Tech. C.F.T.H.* (*No.* 12) 17–34 (*May*, 1949) *In French.*

The importance in acoustic work of a room enabling "free air" measurements to be made is stressed and an indication is given of the necessary dimensions for such a room, if measurements of a given accuracy are to be obtained. A theoretical discussion of absorbing materials is given and the desirable dimensions and form of absorbents are discussed. Finally methods of isolating the room from external interference are given. G. F. HODSMAN

534.632 : 621.317.39

103. Electroacoustic measurements. F. INGERSLEV AND A. K. NIELSEN. *IngenVidensk. Skr.* (*No.* 2) 90–102 (1947) *In Danish.*

Frequency characteristics of loudspeakers and microphones and absolute sound pressure of loudspeakers at various frequencies, polar intensity diagrams, microphone sensitivity, pick-ups and gramophone-cutting investigations are considered. Apparatus is described and illustrated.

J. A. WILCKEN (R)

534.793 : 534.612

104. A new sound-level indicator. (A small loudness and pressure meter). W. HOLLE. *Funk u. Ton*, **3**, 367–72 (*July*, 1949) *In German.*

The need for a flexible, light-weight instrument is discussed and the requirements set by loudness-pressure characteristics, the need for a wide range and for r.m.s. measurements, and the impracticability of feed-back are studied. The instrument is a 5-valve battery-driven unit. A condenser microphone in a spherical housing, giving an approx. omni-directional characteristic is employed, and an equalizing network is included in the 1st stage. A switched potentiometer provides 8 ranges extending from 40 to 110 phons, giving a total coverage of 38–123 phons, while network switching enables readings to be made in μbars. The indicating instrument is a rectifier instrument working on the square-law portion of its characteristic and this, combined with a non-linear resistance network on the d.c. side, ensures an r.m.s. indication with a open scale and covering a wide range. This meter is used as well for checking l.t. and h.t. volts. Output terminals are provided for headphones or the like and provision made for external drive in place of the batteries. The method of calibration is described.

H. G. M. SPRATT

534.8 : 621.396.712.3

105. Building to the acoustical optimum new Mutual-Don Lee broadcasting studios. W. W. CARRUTHERS AND D. P. LOYE. *J. Acoust. Soc. Amer.*, **21**, 428–34 (*July*, 1949).

Three important considerations for optimum design are discussed, namely, size, reverberation characteristic and method of construction. Practical steps taken to meet them are described. The size chosen was 170 000 ft^3 and the optimum reverberation time chosen varied from 2·4 sec at 50 c/s to 1·4 sec at 4 000 c/s. The outside shell was constructed of 8 in thick concrete with an inner wood studio with dimensions conforming to the optimum ratio 2 : 3 : 5. To make the final result agree with calculations, measurements of reverberation time were made at various stages of construction so that succeeding construction could be altered if necessary. A chronological account is given of the reverberation measure-

ments at various stages of construction, also photographs of the building interiors. B. B. AUSTIN (R)

534.838.08 : 621.317.39

106. Mechanical vibrations. F. INGERSLEV AND A. K. NIELSEN. *IngenVidensk. Skr.* (*No.* 2) 35–44 (1947) *In Danish.*

A photocell, an electrodynamic and a capacitance amplitude meter are described and illustrated. In the photocell apparatus the diaphragm is fixed to the vibrating structure, the meter itself being placed on a heavy spring-supported iron block. The electrodynamic meter is a pendulum apparatus, the pendulum carrying a coil swinging in the air gap of a loud-speaker magnet. The theory is given, and some examples of measurements of vibrations caused by traffic, trains, trams and vibrations of a tower during bell-ringing. A vibration generator consisting of 4 rotating eccentrics driven by an electric motor is described. J. A. WILCKEN

534.845

107. Transmission of reverberant sound through single walls. A. LONDON. *J. Res. Nat. Bur. Stand., Wash.*, **42**, 605–15 (*June*, 1949).

The transmission of reverberant sound through homogeneous single walls has been investigated theoretically and experimentally. Random incidence sound-transmission measurements were made on homogeneous walls of aluminium, plywood and plasterboard. A.

OPTICS RADIATION . SPECTRA 535

535 : 778 : 621.385.832

108. Cathode-ray tube applications in photography and optics. C. BERKLEY AND R. FELDT. *J. Soc. Mot. Pict. Engrs*, **53**, 64–85 (*July*, 1949).

Cathode-ray tubes and oscillographs are ideal tools for the solution of many technical problems in the related arts of photography and optics. The methods described represent typical examples of the application of electronic-measurement techniques in such fields. Applications considered and illustrated include: Gloss measurement on photographic papers; goniophotometry of light sources; shutter, flashbulb and synchronizer testing; cathode-ray-tube light sources for facsimile and stroboscopic work; scanning technique for television motion picture recording; the combination of optical and electronic magnification for the study of gear and sprocket imperfections; automatic *H* and *D* curve plotting during film development; cathode-ray-tube sound-on-film recording systems; the measurement of ripple in light sources; colour studies in natural colour reproduction and chromatic aberration in lenses; vibration studies of motion picture equipment. A.

535.23.08

109. A new method of calibration for the Hales radiometer. R. S. SILVER. *Fuel*, **28**, 176–81 (*Aug.*, 1949).

A method is proposed by which the radiometer may be calibrated as a whole with all the elements in situ. The theory underlying the method is explained and experimental results of a calibration are given. A.

535.23.08 : 536.532

110. A method of increasing the speed of response of radiation thermopiles. A. V. HILL. *J. Sci. Instrum. Phys. Ind.*, **26**, 277 (*Aug.*, 1949).

The thermopile is connected to a rapid galvanometer, the deflection of which is amplified photoelectrically. The amplifier-produced potential difference, proportional at any instant to the galvanometer deflection, is fed-back to the thermopile-galvanometer circuit through a high resistance and across a variable capacitor. Sensitivity is sacrificed but speed is gained proportionally. Records of deflections against time made with a large Moll surface thermopile connected to a galvanometer of the Hill–Downing type [*J. Sci. Instrum. Phys. Ind.*, **25**, 225–31 (*July*, 1948), Abstr. 2472–3 B (1948)] and feed-back circuit are shown. S. WEINTROUB

535.231.4

111. On the tube method for determination of the radiation constants of hot bodies. K.-J. EULER. *Z. angew. Phys.*, **1**, 252–6 (*Jan.*, 1949) *In German.*

The radiation from a hot cylinder is converted into black-body radiation by reflection from a coaxial cylinder coated with ZnO of known reflection factor. The corrected black-body temp. of the body is thus known, and from this and its actual temp., its radiation constant is calculated. N. CORCORAN

535.3

112. Research and development in applied optics and optical glass at the National Bureau of Standards. I. C. GARDNER AND C. H. HAHNER. *Misc. Publ. U.S. Bur. Stand.* (*No.* 194) 19 *pp.* (1949).

A general account of the research and development work in technological optics that has been completed at the N.B.S. Noteworthy accomplishments include the production of a 70 in optical disc; a comprehensive study of the relation between chemical composition and index of refraction of optical glass; a study of the relation between annealing temp. and index; the design and construction of an $f/6{\cdot}3$ aeroplane camera lens of 50 in focal length; the design and construction of large interferometers; the construction of a special laboratory for testing range finders and similar tasks. A list of 195 Bureau publications pertaining to optical glass and optical instruments is included. A.

535.31

113. Trajectories of skew rays. G. TORALDO DI FRANCIA. *Atti Fond. "Giorgio Ronchi,"* **4**, 26–9 (*Feb.–April*, 1949) *In Italian.*

A proof, using vectorial mechanics, of the theorem by means of which a skew ray may be traced through an optical system having rotational symmetry in the same way as a meridional ray. H. H. HOPKINS

535.31

114. The general condition that two infinitely close image-waves be related by a fixed law. (The general differential law for two independent waves.) M. DI JORIO. *Rev. Opt.* (*Théor. Instrum.*) **28**, 400–5 (*July*, 1949) *In French.*

Discusses necessary and sufficient conditions for

the stigmatic imagery of two close point sources by any optical system. H. H. HOPKINS

535.311 : 535.421

115. Note on the geometrical optics of diffracted wave-fronts. F. G. FRIEDLANDER. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 3) 395–404 (1949).

The wave-equation in two spatial dimensions leads to a space-time (x,y,t) representation of the disturbance. At point P (x_0,y_0,t_0) a 90° cone is constructed, having its axis in the t-direction. The two half-cones $t < t_0$, $t > t_0$ are defined as the dependence and influence zones of P. The disturbance can then be found as the solution of a "boundary value" problem. Three lemmas lead to (*inter alia*) Fermat's principle and Huygens' principle. The treatment is generalized to the case of n spatial dimensions. H. H. HOPKINS

535.313.6

116. Study of a reflecting system composed of three spherical mirrors. A. COLACEVICH. *Atti Fond. "Giorgio Ronchi,"* **4**, 15–22 (*Feb.–April*, 1949) *In Italian.*

In a concentric system the axial spherical aberration defines the aberration for all points of the image, the object being at a great distance. The third-order spherical aberration of the 3 mirror system is studied. One system so found had a circle of confusion of diameter $= 6\,\mu$, the e.f.l. being 50 mm and the F number 0·86. H. H. HOPKINS

535.317

117. Objective lenses of *f*/1 aperture and greater. E. K. KAPRELIAN. *J. Soc. Mot. Pict. Engrs*, **53**, 86–99 (*July*, 1949).

The factors involved in the design of large-aperture objectives are discussed and some of the general approaches to the reduction of the various aberrations are presented. Diagrams, classification and source references of most objectives of $f/1$ aperture or greater which have been published are included. Both refracting and reflecting systems are considered, including objectives having spherical and aspherical surfaces and those employing the immersion principle. Applications, testing and performance of extreme-aperture objectives are discussed. Extensive bibliography. A.

535.317

118. Flat-fielded reflecting micro-objectives. R. L. DREW. Letter in *Nature, Lond.*, **164**, 360 (*Aug.* 27, 1949).

Gives details of two aspheric surfaces which give a flat field without chromatic focal errors. Full compensation is possible for any refractive index by suitable choice of entry surfaces. N. CORCORAN

535.317.3

119. On the variation of the axial aberrations of a photographic objective with variation of the distance of the object. G. TORALDO DI FRANCIA. *Atti Fond. "Giorgio Ronchi,"* **3**, 93–8 (*June–Aug.*, 1948) *In Italian.*

Expressions are given for the variation with object distance of primary chromatic aberration (measured as a longitudinal intersection difference) and of the spherical aberration of an objective. H. H. HOPKINS

535.317.4

120. The dependence of the aberrations of an optical system on small displacements of the object. D. YU. GALPERN. *J. Tech. Phys., USSR*, **18**, 295–302 (*March*, 1948) *In Russian.*

An expression is given for the aberration of the ray with respect to the co-ordinate determining the position of the object plane. A generalized form of the Herschel condition is also given. A practical example is calculated. B. F. KRAUS

535.317.4

121. Investigations of the influence of spherical aberration on the quality of the image in photographic objectives. I. THAMM. *Bull. Univ. Tech. Sci. Budapest* (*No.* 3) 199–214 (1948) *In German.*

An elaborate discussion, based on the geometrical circle of confusion, of the correction of spherical aberration. The "best" focus is determined by applying a method of least squares to the longitudinal aberration as measured from a variable image plane. There is no mention of diffraction considerations. H. H. HOPKINS

535.317.4

122. On the variation of the astigmatism of a photographic objective with variation of the distance of the object. G. TORALDO DI FRANCIA. *Atti Fond. "Giorgio Ronchi,"* **3**, 99–106 (*June–Aug.*, 1948) *In Italian.*

It is shown how the astigmatism along a principal ray may be found for any position of the object point along the ray when the infinity focus is known. H. H. HOPKINS

535.317.4

123. Dependence of spherical aberration on the distance of the object. G. TORALDO DI FRANCIA. *Atti Fond. "Giorgio Ronchi,"* **4**, 127–31 (*Aug.*, 1949) *In Italian.*

Herschel's condition for longitudinal isoplanatism holds only when the spherical aberration is given as a function of the angular aperture. But in real optical systems the linear aperture of the pupil is fixed, whereas the angular aperture varies as object and image are shifted along the axis. It is therefore customary to express the spherical aberration as a function of the height of incidence on the pupil. In this case Herschel's condition needs a correction. The new condition is the longitudinal analogue of Staeble–Lihotzky's condition for lateral isoplanatism. Formulae are then deduced for calculating the variation of the image plane. Longitudinal isoplanatism is demonstrated to be inconsistent with lateral isoplanatism. A.

535.317.4 : 612.84

124. An attempted explanation of the spherical aberration of the eye and its variation with the state of accommodation. A. IVANOFF. *C.R. Acad. Sci., Paris*, **228**, 126–7 (*Jan.* 3, 1949) *In French.*

The differences between the measured spherical aberration and that calculated on the assumption of spherical surfaces is attributed to the existence of non-uniform effective refractive index of the crystalline lens. This latter is considered as having a small central core and a peripheral part, the indices of both of which vary during accommodation. A qualitative account of the measured aberration is given on this basis. H. H. HOPKINS

535.317.5

125. Conditions for the annulment of monochromatic aberration of any order in a monocentric system. A. COLACEVICH. *Atti Fond. "Giorgio Ronchi,"* **4**, 23–5 (*Feb.–April*, 1949) *In Italian.*

Considers the axial spherical aberration of a monocentric system of refracting surfaces. Conditions are given for the aberration coeff. of any given order to be zero. H. H. HOPKINS

535.317.5

126. The aberrations of the seventh order. C. MORAIS. *An. Real. Soc. Esp. Fis. y Quim. A*, **45**, 223–46 (*May–June*, 1949) *In Spanish.*

A study is made of the aberrations of the 7th order presented by a plane-parallel lamina in the air. The forms of the aberrations are discussed, and a comparative study is made with those of the 3rd and 5th order. The method of obtaining the values of the aberration coeffs. to the 7th order by trigonometric progressions is also shown. A.

535.317.5

127. General third order imagery. H. GRENAT. *Rev. Opt.* (*Théor. Instrum.*) **28**, 389–99 (*July*, 1949) *In French.*

A transformation of Chretien's expression for the transverse aberration of a ray in the meridian section. The introduction of new variables shows that, by the use of an additional coeff., the third-order aberrations of a system may be found for any position of the object plane, when they are known for one.

H. H. HOPKINS

535.327 : 548.0

128. The thermo-optic behaviour of mica. T. RADHAKRISHNAN. *Proc. Indian Acad. Sci. A*, **28**, 447–53 (*Nov.*, 1948).

The temperature variation of two of the refractive indices of muscovite mica was determined by an interference method which can be utilized for other solids as well. The experimental values are discussed theoretically and shown to conform to the general behaviour of transparent solids as given by Ramachandran's theory [Abstr. 2479 (1947)]. A.

535.33.03 : 537.523.4

129. On the excitation temperature in a spectroscopic spark source. C. J. BRAUDO, J. D. CRAGGS AND G. C. WILLIAMS. *Spectrochim. Acta*, **3** (*Nos 5–6*) 546–59 (1949) *In English.*

It is possible to deduce the excitation temp. in a gaseous discharge, if spectral lines of known transition probabilities are excited in the discharge and their relative intensities measured. This technique is applied in some preliminary experiments on a new spectrographic spark source. The results show that excitation temperatures of 5 000–15 000° may be encountered. The effects of variations in circuit constants are studied. Rotating mirror photographs of the metal vapour clouds emitted from the electrodes are included. A.

535.33.03 : 537.525.5

130. Increase of the stability of glowing of the activated alternating-current arc in spark-type operation for the purposes of spectral analysis. I. S. ABRAMSON AND O. B. FALKOVA. *J. Tech. Phys., USSR*, **19**, 611–15 (*May*, 1949) *In Russian.*

Three wiring diagrams for connecting the generator of an a.c. arc are described, ensuring better stability in spark-type operation. F. LACHMAN

535.33.072

131. Results obtained with a new type of spectrograph for astronomical use. M. HACK. *Atti Fond. "Giorgio Ronchi,"* **4**, 132–4 (*Aug.*, 1949) *In Italian.*

535.33.072

132. Reflecting spectrograph of high intensity. G. TORALDO DI FRANCIA. Letter in *Atti Fond. "Giorgio Ronchi,"* **3**, 114–15 (*June–Aug.*, 1948) *In Italian.*

The third-order astigmatism and coma of a plane reflection grating are corrected (for a given order) by means of a parabolic mirror, at which light from the source is first reflected. H. H. HOPKINS

535.331

133. Structure of arc spectrum of Re. R. VELASCO. *An. Real. Soc. Esp. Fis. y Quim. A*, **45**, 215–18 (*May–June*, 1949) *In Spanish.*

The arc spectrum of Re is reviewed, some new levels are mentioned and the lowest odd levels are arranged in terms. A.

535.331

134. On the structure of the resonance line of Hg filtered through Hg vapour. G. S. KASTHA. *Indian J. Phys.*, **23**, 247–52 (*June*, 1949).

The structure of the resonance line 2 536·6 Å of Hg filtered through a cell containing Hg vapour at different temps. and pressures has been studied with a large quartz spectrograph. It has been observed that the Hg vapour in the absorption cell absorbs only the central portion of the resonance line, there being a feeble line transmitted on each side of the centre. The distance between these 2 lines increases to about 18 cm^{-1} when the temp. of the Hg in the absorbing cell is raised to 100°C. The intensity of these 2 lines is $\ll$ that of the line 2 534·8 Å and is of the same order of magnitude as that of the Brillouin components observed by Krishnan in the case of diamond. It is pointed out that as the separation and the intensity of those Brillouin components are the same as those of the doublet in the resonance line filtered through Hg vapour it is doubtful whether the lines observed by Krishnan are genuine Brillouin components in the light scattered by diamond. A.

535.331

135. Forty electron system of molybdenum–Mo III. V. RAMAKRISHNA RAO. *Indian J. Phys.*, **23**, 258–64 (*June*, 1949).

The line spectrum of Mo was photographed under different conditions of excitation from λ6800 to λ1950. Multiplets of Mo III due to the combination of $4d^5\,5s\,{}^3F$ with $4d^3\,5p\,{}^5(DFG)$ were identified from a scrutiny of the plates. A.

535.331

136. New levels in the uranium spark spectrum (U II). J. C. VAN DEN BOSCH. *Physica*, **15**, 503–22 (*July*, 1949) *In English.*

392 lines have been added to the list of classified lines.

535.332

137. The Stark effect of some supermultiplets in the arc spectrum of silicon. K. LIDÉN. *Ark. Fys.*, **1**, *Paper* 7, 213–20 (1949) *In English.*

The influence of electric fields on the Si I terms

(^2P) $5p$ and (^2P) $5f$ has been measured. At the field strength 100 kV/cm the displacements of the $5p$ levels range from 0 to 4 cm^{-1}. The displacements of the $5f$ levels at 60 kV/cm range from 10 to 20 cm^{-1}. The $5p$ ^3P levels show an interesting case of perturbation, due to the influence of the $4d$ ^3F levels. The Stark effect theory for Russell–Saunders' supermultiplets is discussed and applied to the perturbations of the Si I polyads (^2P) $5p$ $^1S^1P^1D$, (^2P) $5p$ $^3S^3P^3D$. A.

535.332

138. The arc spectrum of fluorine. K. LIDÉN. *Ark. Fys.*, **1**, *Paper* 9, 229–65 (1949) *In English.*

The F I arc spectrum has been investigated in the i.r., visible, u.v. and vacuum regions using suitable types of water-cooled hollow cathode discharge tubes as light sources. About 370 new lines have been identified and 67 new energy levels established. The ns- and nd-series can be unambiguously assigned to the components of the limit ^3P and they show almost perfect J_1l- or pair-coupling. Series of ns- and nd-levels are in excellent agreement in fixing the series limits within $\pm 0{\cdot}1$ cm^{-1}, giving an ionization potential of 17·418 V. The hyperfine structure has been studied with the Fabry–Perot interferometer and the strongest lines have been interferometrically measured against Ne I standards. A.

535.332

139. The spectrum of highly ionised iodine—I VI. S. G. KRISHNAMURTY AND I. FERNANDO. *Indian J. Phys.*, **23**, 172–4 (*April*, 1949).

Using the regular and irregular doublet laws, appropriate lines possibly belonging to the spectrum of I VI have been identified from the far u.v. data of highly ionized I due to Blochs and Felici [*J. Phys. Radium*, **8**, 9 (1937)] and a scheme set up. The important intervals $5p$ ($^3P_0 - {}^3P_1$) and $5p$ ($^3P_1 - {}^3P_2$) have been found to be 3 593 cm^{-1} and 10 424 cm^{-1} respectively. A.

535.332 : 537.228.5

140. Stark effect for a hydrogen atom in its ground state. G. L. SEWELL. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 4) 678–9 (1949).

The uniform electric field is treated as a small perturbation allowing the energy to be quantized. Energy is approximated to the 8th term, using the self-adjoint property of the operator $H_0 - E_0$ [H_0, E_0, Hamiltonian and energy of an isolated H atom]. J. JACOBS

535.333

141. Band spectrum of thallium iodide. P. TIRUVENGANNA RAO AND K. R. RAO. *Indian J. Phys.*, **23**, 185–98 (*May*, 1949).

An extensive band system attributed to the diatomic molecule TlI, has been obtained for the first time in emission between λ5300–λ3800 in a high frequency discharge with external electrodes. The bands at the violet end are red-degraded; those in the central portion are headless; at the red end they are diffuse and broad. A number of them occurs in well-separated groups, each consisting of 4 or 5 equi-spaced components with an interval of about 28 units; the intensity among these rises gradually to a max. and then falls off. The system has been interpreted as due to the transition $^3\pi_1 - {}^1\Sigma^+$ with the origin near the extreme violet end. A vibrational analysis which includes most of the band heads, has led to the following formula: $\nu = 25\,794{\cdot}2 + (91{\cdot}2\,u' - 0{\cdot}09\,u'^2) - (121{\cdot}0\,u'' - 0{\cdot}09\,u''^2)$. A second brief system of about 25 slightly violet degraded bands is also obtained between λ3680–λ3600. 4 diffuse groups of bands, overlaid by a continuum, are measured. The system has been interpreted as the component $^3\pi_0^+ - {}^1\Sigma^+$ having the same lower state as that of the main system. Electron transitions are compared for the observed band systems of the 4 halide molecules of Tl. A.

535.333

142. The near ultra-violet spectra of benzene. I. The emission bands. R. K. ASUNDI AND M. R. PADHYE. *Indian J. Phys.*, **23**, 199–216 (*May*, 1949).

An emission spectrum of C_6H_6 in the near u.v. is excited by a transformer discharge through flowing C_6H_6 vapour. The spectrum which was previously recorded by Austin and Black, and Asundi and Padhye, has been considerably extended and a large number of bands, 200 or more, have been photographed and measured. A full analysis of the bands is proposed which is on the basis of that of the absorption spectrum of benzene by Sponer *et al.* The results afford further proof of the correctness of the theoretical deductions regarding this molecule and its excited levels put forward by Hückel Sklar, Pauling and others. The main results of the present investigations are the following: (1) The emission spectrum obtained is the counterpart of the corresponding absorption spectrum, the transition involved being $B2u \rightarrow A1g$. (2) As is to be expected, the spectrum yields much more information about the ground state of the molecule than either absorption or fluorescence spectrum. (3) It also exhibits a pronounced development of doublets due to Fermi resonance between the 2 vibrations 1 596 cm^{-1} (e_g^+) and 606 cm^{-1} 992 cm^{-1} ($e_g^+ + a_{1g}$) which are traced up to 4 quanta of 992 cm^{-1}. These are further associated with 5 quanta of 160 cm^{-1} difference frequency. A.

535.333

143. The near ultraviolet spectra of benzene. II. A comparative study of the absorption, emission and fluorescence bands. R. K. ASUNDI AND M. R. PADHYE. *Indian J. Phys.*, **23**, 237–46 (*June*, 1949).

It is found that the intensity distribution in the emission spectrum is substantially different from that in the absorption spectrum at room temp. and appears to be governed by the Boltzmann factor in the excited state and the Franck–Condon principle. The intensity distribution also differs from that of fluorescence bands in which the distribution is generally governed by the conditions of excitation. The emission spectrum gives data for a more complete picture of the state of the molecule and the selection rules governing the transition to which all the 3 spectra are due. A.

535.333

144. Ultraviolet absorption spectra of seven substituted benzenes. R. STAIR. *J. Res. Nat. Bur. Stand., Wash.*, **42**, 587–93 (*June*, 1949).

The substances were *n*-, *iso*-, *sec*- and *tert*-butyl-

benzene and 1,2-, 1,3- and 1,4-diethylbenzene. Measurements were made in the region 220–300 mμ. A.

535.333

145. Emission spectra of the manganese halides. P. T. Rao. *Curr. Sci.*, **18**, 245 (*July*, 1949).

535.338 : 537.523.4

Spectrum of a torch discharge. *See Abstr.* 290

535.338.1

146. Emission spectrum of compressed hydrogen. C. Weniger and L. Herman. *C.R. Acad. Sci., Paris*, **229**, 185–7 (*July* 18, 1949) *In French.*

Spectra are obtained for pressures up to 160 kg/cm², using a high tension discharge without condenser. At 5 kg/cm² there are numerous lines due to the electrodes and to gas impurities, while the Balmer lines are widened. As the pressure increases, at the highest measured a continuum stretches all along the region to which the plate is sensitive and the optics are transparent, below 2 100 Å and up to 9 000 Å. Increase of pressure seems to have the same effect as increase of current density. Ion density is very high, and this is the cause of the broadening of the lines and the extension of the continuum towards the long waves. The field in the gas at the highest pressure is estimated at 6 MV/cm. A. C. G. Menzies

535.338.332

147. Hyperfine structure of Te^{125}. G. R. Fowles. Letter in *Phys. Rev.*, **76**, 571 (*Aug.* 15, 1949).

Observed with a Fabry–Perot etalon in a water-cooled Schuler tube, containing 20 mg of 80% enriched isotope. About 12 lines from 4 000 to 6 000 Å show a doublet structure, interval about 0·2 cm^{-1}. In some lines (e.g. 5 666) the intensity ratio of components is 3 : 1; it is concluded that the spin is ½. A. C. G. Menzies

535.338.333

148. Spectral examination of selectively reflected lines. Structure of the *Bc* hyperfine component of the 2 537 Å mercury line. J.-L. Cojan and R. Lennuier. *C.R. Acad. Sci., Paris*, **228**, 1710–12 (*May* 30, 1949) *In French.*

Selective reflection of a resonance line is used. The method is tried out on line *X*202 and the delicacy of the method is demonstrated provided the pressure is kept low. It is then applied to the hyperfine component *Bc*, where *B* is due to isotope 199 and *c* to isotope 201. These two lines have not been separated before. *c* is about 0·9 mÅ from *B*, on the short wave side. A. C. G. Menzies

535.338.333

149. Thallium isotope effect in the band spectrum of thallium bromide. P. Tiruvenganna Rao. *Indian J. Phys.*, **23**, 265–8 (*June*, 1949).

Bands of TlBr, excited by a h.f. discharge through the vapour, are photographed in the first order of a 10 ft concave grating. The isotope effect due to Tl^{203} is established for the first time from measurements on the splitting observed in many of the band heads between λ4300–λ4100. A.

535.338.4

150. A new ultra-violet band-system of GeCl. R. F. Barrow and A. Lagerqvist. *Ark. Fys.*, **1**, *Paper* 8, 221–9 (1949) *In English.*

The vibrational analysis of a new band-system of GeCl is reported. The upper state is probably $^2\Delta$, and the lower state is the $^2\Pi$ ground state of GeCl. Vibrational constants are derived and similarities between the spectra of GeCl and SnCl are noted. A.

535.338.4

151. New bands of the Asundi band-system of CO. S. N. Garg. *Indian J. Phys.*, **23**, 161–71 (*April*, 1949).

A large number of bands has been recorded in an uncondensed discharge through a tube containing $SnBr_4$ at very low pressure and C as the usual impurity. Most of them are found to belong to the Asundi system ($a'^3\Sigma \rightarrow a^3\pi$) of CO. The following is the equation found to represent satisfactorily these bands as well as the already known ones of this system:

$$\nu = 6\,953{\cdot}6 + (1\,208{\cdot}6\,v' - 9{\cdot}5\,v'^2) - (1\,726{\cdot}5\,v'' - 14{\cdot}4\,v''^2)$$

$$\text{or } \nu_e = 7\,213{\cdot}8 + (1\,218{\cdot}1\,u' - 9{\cdot}5\,u'^2) - (1\,740{\cdot}9\,u'' - 14{\cdot}4\,u''^2),$$

where $u = v + \frac{1}{2}$ and the v' numbering is that proposed by Gerö and Lorinczi. A few bands which cannot find suitable places in the system appear to be fragments of an unknown system. A.

535.338.4

152. The Fox–Herzberg system of the C_2 molecule. J. G. Phillips. *Astrophys. J.*, **110**, 73–89 (*July*, 1949).

9 new bands have been observed in the spectrum of the C_2 molecule between 2 370 Å and 3 855 Å. They are degraded to the red and do not have pronounced heads. An analysis of the bands has shown that they are additional members of the Fox–Herzberg system ($B^3\Pi_g - X^3\Pi_u$). Their discovery makes possible a more complete discussion of the molecular constants of the $B^3\Pi_g$ state. The resulting rotational constants, B'_e and α'_e, are 1·1922 cm^{-1} and 0·0242 cm^{-1}, respectively. A.

535.338.4

153. The band spectrum of TiCl. V. Ramakrishna Rao. *Curr. Sci.*, **18**, 245 (*July*, 1949).

535.338.4

154. The band spectrum of nitric oxide in the visible region. Y. Tanaka and M. Ogawa. *J. Sci. Res. Inst., Tokyo*, **44**, 1–5 (*Sept.*, 1949).

535.338.4 : 523.67

Carbon monoxide emission in the region of the 4 050 Å group in cometary nuclei. *See Abstr.* 10

535.339

155. A vacuum ultraviolet monochromator for absorption and photoconductivity measurements on luminescent solids. W. W. Parkinson, Jr. and F. E. Williams. *J. Opt. Soc. Amer.*, **39**, 705–8 (*Aug.*, 1949).

A vacuum u.v. monochromator for the region 1 000 Å to 2 000 Å is described in detail. The limited range makes rotation of the grating about a point

and simplified construction feasible, since the loss of resolution at the extreme of wavelength is only 0·1% of the measured wavelength. The spectrum of the H source and a typical absorption curve are given. A.

535.34

156. Derivation of the Lambert–Beer law on purely geometrical and mathematical basis. A. SIPPEL. *Z. Naturforsch.*, **4a**, 179–82 (*June*, 1949) *In German.*

A general law of light absorption is derived by considering the passage of a light quantum through a suspension of opaque spheres in a transparent medium. At low concentrations the result is identical with the Lambert–Beer law; and the deviations from the latter at higher concentrations are $\gtrsim$ experimental errors in absorption measurements. Observed deviations from the Lambert–Beer may therefore be interpreted safely as indicating molecular interactions.

C. B. ALLSOPP

535.341

157. Effective path length in cylindrical cells. G. HANSEN AND E. MOHR. *Spectrochim. Acta*, **3** (*Nos* 5–6) 584–97 (1949) *In German.*

In measurements of extinction coeffs. or optical activity in rotating the plane of polarization the length of the absorption cell must be accurately known. If the cross-section of the light beam in the cell is $\ll$ its length, the effective length = the geometrical length. If the cross-section is $\geqslant$ the cell-length the effective length is $>$ the geometrical length by a factor which varies with the extinction coeff. of the fluid. The necessary correction factor is calculated for various types of illumination. The effect of different optical arrangements of the absorbing substance in the path of the instrument is examined, and it is shown that for a given cell-length the minimum volume of fluid is required when the two faces of the absorption cell are imaged on the corresponding apertures of the photometer. The case where the light at one end of the cell traverses a slit is also examined. A.

535.343

158. Vibrational spectrum and infra-red polarization measurements for malononitrile. F. HALVERSON AND R. J. FRANCEL. *J. Chem. Phys.*, **17**, 694–703 (*Aug.*, 1949).

The i.r. spectra of gaseous, liquid and solid malononitrile have been obtained using a spectrometer equipped with LiF, NaCl and KBr prisms. Polarization measurements on a linearly oriented preparation of solid malononitrile using a transmission polarizer were of material assistance in the classification of absorption bands into their respective species. These data, together with the Raman data in the literature and a normal co-ordinate treatment, permitted a complete assignment of the 15 fundamental frequencies and a determination of the force constants and thermodynamic functions for the molecule. A.

535.343.4

159. Some new features of the green and u.v. bands of Na_2 and the blue bands of K_2 and of the continua accompanying these bands. S. P. SINHA. *Indian J. Phys.*, **23**, 229–36 (*May*, 1949).

Description of the behaviour of the green, the λ3600–λ3200 Å bands and the λ3050–λ2860 Å bands of Na_2 and the λ4550–λ4150 Å bands of K_2 and also of the continuous absorption spectra accompanying these bands, under varying conditions of temp. and pressure, is given. An attempt has been made to explain the features observed according to Franck–Condon principle, on the assumption that increase of temp. or pressure favours the formation of quasi-molecules, whose potential energy curves are the same as those of the stable Na_2 or K_2 molecules in their normal state. A.

535.343.4

160. Infra-red absorption of hydrogen and carbon dioxide induced by intermolecular forces. H. L. WELSH, M. F. CRAWFORD AND J. L. LOCKE. Letter in *Phys. Rev.*, **76**, 580 (*Aug.* 15, 1949).

Rotation-vibrational absorption for H_2 and for CO_2 in the infrared has been reported. The H_2 absorption is enhanced by foreign gases (He and N_2). Contours substantiate the rotational selection rule $\Delta J = 0, \pm 2$. The H_2 band at 4 155 cm^{-1} is partly resolved into Q, and O and 5 branches, the Q branch having a $\frac{1}{2}$-width of 250 cm^{-1}. The symmetrical frequency of CO_2 has been observed, using a path length of 85 cm and gas pressures up to 25 atmos., although normally this frequency is not infrared-active. W. R. ANGUS

535.343.4–14 : 539.13

The microwave spectrum of $CF_2{=}CH_2$. *See Abstr.* 408

535.343.4–14 : 539.152.2

Nuclear moments from microwave spectra. *See Abstr.* 429–33

535.343.4–15

161. The infra-red spectrum of $C^{14}O_2$. R. K. SHELINE AND J. W. WEIGL. Letter in *J. Chem. Phys.*, **17**, 747 (*Aug.*, 1949).

The observed fundamentals $\nu_2 = 632$, $\nu_3 = 2\,220$ cm^{-1} agree with $C^{12}O_2$ frequencies and the Redlich–Teller product rule. D. H. WHIFFEN

535.37

162. Phosphors and phosphorescence. G. F. J. GARLICK. *Rep. Phys. Soc. Progr. Phys.*, **12**, 34–55 (1948–49).

Reviews recent investigations of the luminescence characteristics of impurity-activated phosphors and the basic processes involved. The development of the electron energy band model of crystalline phosphors and experimental support for it is discussed. Phosphorescence of long duration has been shown to be due to the trapping of electrons in thermally metastable levels in phosphors: correlation of phosphorescence and thermoluminescence due to such electron traps has been achieved. The nature of traps is only known for a few types of phosphor. There have been important advances in the knowledge of the structure of luminescence emission centres in sulphide and silicate phosphors: in ZnS phosphors with Cu or Ag impurity the centres are thought to be based on molecular halide groups formed by the impurity and the halogen which has to be included to obtain luminescence at all. A section is devoted to the relation of the emission spectra of Mn-activated silicate phosphors to the state of co-ordination of the

Mn and the action of certain additional impurities, such as As and Sn, in promoting phosphorescence of long duration in these materials. Recent studies of oxide and tungstate phosphors are mentioned. A brief summary of the recent development of phosphors sensitive to the stimulating action of infrared radiation is given. It is found that a secondary activator is necessary to obtain marked stimulability. Although experimental data on the basic processes are sparse, it appears that infrared light results in the ejection of trapped electrons. However, there seems to be no simple correlation between the process of optical ejection of trapped electrons and the thermal ejection which takes place during thermoluminescence. A.

535.37

163. The intensity dependence of the efficiency of fluorescence of willemite phosphors. W. Hoogenstraaten and F. A. Kröger. *Physica*, **15**, 541–56 (*July*, 1949) *In English.*

The efficiency of the fluorescence of Zn silicate activated with a high concentration of Mn is dependent on the temp. and on the exciting intensity when excited by u.v. The efficiency is constant over a wide range of low exciting intensities, increases at intermediate exciting intensities and will probably tend to a constant value again at high exciting intensities. Similar effects are observed with Zn_2SiO_4–Mn_2SiO_4 in which small quantities of Fe_2SiO_4 have been incorporated. This behaviour can be explained on the basis of the theory of hole-migration for bimolecular phosphors of Schön–Klasens if the roles of positive holes and excited electrons in that theory are interchanged. Values of the activation energies for migration from fluorescence centres and killer centres are computed, and the theoretical temp. dependence curves calculated from these data for different intensities are shown to be in accordance with the observed curves. A.

535.37

164. Temperature quenching and decay of fluorescence in zinc and zinc-beryllium silicates activated with manganese. F. A. Kröger and W. Hoogenstraaten. *Physica*, **15**, 557–68 (*July*, 1949) *In English.*

Zn silicate and Zn–Be silicate activated by Mn contain various types of fluorescence centres which differ in the wavelength of the emitted radiation, the probability of the fluorescence transition, and the vibrational interaction with the surroundings which regulates the dissipation of energy of excitation. The centres are assumed to be Mn ions with different numbers of other Mn ions at neighbouring sites (clusters). Quenching of fluorescence is due to radiationless processes starting from the excited state of the centres (characteristic quenching). If particular conditions are fulfilled, however, quenching may also occur from (higher) excited states of a different type. In this case energy of excitation is transferred to centres especially suited for the dissipation of energy (quencher centres). This type of quenching is found in Zn silicates at medium Mn concentrations, and in Zn and Zn–Be silicates containing foreign quenchers (Fe). It is assumed that quencher centres are fluorescence centres with a low quenching point. A.

535.371

165. A new phosphor. H. Gobrecht. *Phys. Bl.*, **5** (*No.* 2) 62–3 (1949) *In German.*

Alkali and alkali earth sulphates heated in a reducing atmosphere give phosphorescent products.

J. EWLES

535.371

166. New method of investigating the processes of growth and decay of luminescence. N. A. Tolstoĭ and P. P. Feofilov. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13** (*No.* 2) 211–17 (1949) *In Russian.*

A general method of studying relaxation phenomena has been worked out using a specially designed sweep circuit equipped with a time-base following approximately the law of the process studied. When the method is applied to the processes of growth and decay of luminescence, the value of the parameter τ (from the exponential time-function $x = x_0\varepsilon^{-t/\tau}$) can be measured with an accuracy of about 1% (under favourable conditions). F. LACHMAN

535.371

167. Dependence of luminescence yield on temperature and its connection with other properties of zinc sulphide. N. Ril. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 2) 245–50 (1949) *In Russian.*

The equation $N_T/N_0 = \sigma_0/(\sigma_0 + \text{const} \times \sigma_T)$ of Szigeti and Nagy [Abstr. 587 (1948)] can be simplified to $N_T/N_0 = 1/(1 + Ae^{-B/2kT})$. The latter equation gives excellent results when applied to the dependence of luminescence yield on temp. not only in the case of silicates but also ZnSAg, ZnCdSAg, BaSeCu, ZnS, etc. The Szigeti–Nagy explanation of the equation is criticized, and the new equation is derived from the theory suggested by the author [*Lumineszenz und ihre technische Anwendung*, 102–20 (1941)] and M. Schön [Abstr. 2151 (1944)]. F. LACHMAN

535.371

168. Relation between the emission spectrum of a sublimed-phosphor KI–Tl and temperature. K. V. Shalimova. *J. Exp. Theor. Phys., USSR*, **19** (*No.* 8) 753–5 (1949) *In Russian.*

Films of a sublimed phosphor of KI–Tl were formed by simultaneous evaporation in air of KI and metallic Tl on to quartz plates. The plates were subjected to monochromatic light of $\lambda = 2\,537$, 2 652, 3 020 and 3 125 Å and the spectra photographed at room temp., +150°c and −100°c. At +150°c it was found that for all λ's the relative height of the short λ maximum at 4 500 Å was $>$ the long λ maximum at 5 300 Å. At −100°c the long λ maximum on the other hand was $>$ the short λ maximum. This change with temp. is similar to what has been observed for KI–Tl films with low concentrations of activator. The temp. relationship of the luminescence spectra of the sublimed phosphor KI–Tl makes it possible to explain the change of absorption of monocrystals of KI–Tl observed with temp. change.

W. HUGHES

535.371

169. Phosphorescence of organic substances. H. Schüler, A. Woeldike and L. Reinebeck. *Z. Naturforsch.*, **4a**, 124–30 (*May*, 1949) *In German.*

It has been found that the blue phosphorescence spectra of various benzol derivatives are very similar

to each other and to the Goldstein "Vorspektren" obtained in discharge tubes. Long irradiation brings out also a green spectrum which is again similar in each case and to the "Hauptspektren" in the discharge. It is deduced from these similarities that the phosphorescence is due in both green and blue spectra to emission from free radicals and not, as Lewis and Kasha supposed [Abstr. 1425, 2940 (1945)], to triplet states of the whole molecule. J. EWLES

535.371

170. A survey of present methods used to determine the optical properties of phosphors. W. B. NOTTINGHAM. *J. Opt. Soc. Amer.*, **39**, 641–7 (*Aug.*, 1949).

A brief review of the theory of phosphors is given in terms of the electron-band picture of impurity semiconductors in order to show the reasons for researches designed to obtain the optical properties of phosphors. The automatic spectroradiometer is described since it is an instrument which yields so much information of value in phosphor research, development and quality control. Some problems of spectroradiometer standardization are discussed in some detail, since the data obtained cannot be correctly interpreted by the I.C.I. system of colour specification and interpretation unless satisfactory standards are maintained and used. A brief discussion is given of the application of the I.C.I. system to help in the choice of phosphors required to produce a suitable "white" for television cathode-ray tubes. Other researches discussed include the determination of phosphor excitation curves, the emission of light as a function of temp. and of time, and the correlation of spectral excitation and absorption data. A.

535.371

171. Review of the interpretations of luminescence phenomena. F. E. WILLIAMS. *J. Opt. Soc. Amer.*, **39**, 648–54 (*Aug.*, 1949).

After a brief discussion of the importance of the interpretations of luminescence phenomena to the design and improvement of phosphors and to the modern electronic theory of solids, the general theoretical approaches and models are presented. The particular scopes of application and limitations of the electronic band theory model and the configurational co-ordinate model are stressed. Phenomenological analyses of temperature-quenching of efficiency and afterglow, two-stage afterglow, thermoluminescence, electron retrapping and positive hole migration, that have been developed and emphasized during the past decade, are reviewed and compared with experimental data. In addition, the atomistic interpretations that have been qualitatively developed and are being quantitatively refined are briefly presented. The need for an absolute theory of luminescence, by means of which the significant properties of phosphors can be quantitatively computed from first principles, is emphasized. A.

535.371

172. New observations on superlinear luminescence. N. R. NAIL, F. URBACH AND D. PEARLMAN. *J. Opt. Soc. Amer.*, **39**, 690–4 (*Aug.*, 1949).

In earlier papers [*J. Opt. Soc. Amer.*, **36**, 709 (1946)] it was shown that a group of phosphors show an approximately linear increase of their efficiency with increasing intensity of excitation in certain ranges of that intensity. Tentatively, these observations and the interdependence of the effects of intensity, temp. and "poisoning" found in the same phosphors were interpreted by the assumption that a non-radiative process of first-order kinetics competes with an emission process of the second order. This type of hypothesis, however, does not easily account for more than linear dependences of efficiency on intensity. Indications of such dependences had been found in earlier work. In view of the possible theoretical significance of these results, a number of measures was taken to eliminate possible sources of errors. New measurements were carried out on a suitable series of poisoned zinc-cadmium sulphide phosphors. The existence of regions in which the intensity dependence of efficiency was even stronger than quadratic was ascertained. Furthermore, a remarkably strong dependence of the efficiency on the carefully controlled concentrations of the poison was found. The problems raised by these effects are briefly discussed. A.

535.371

173. Simplified Lenard phosphors. D. PEARLMAN, P. E. GODDARD AND F. URBACH. *J. Opt. Soc. Amer.*, **39**, 695–8 (*Aug.*, 1949).

Attempts were made to obtain well-defined and simple singly activated SrS phosphors. This paper is concerned with the effect of SrO, an unavoidable constituent of SrS phosphors, on Cu- or Bi-activated SrS phosphors with $SrCl_2$ as flux. 2 different phenomena are encountered with variation in concentration of SrO. One, observed with both Cu and Bi activation, is a gradual shift in emission. The other, obtained with Bi-activated phosphors, is a surprisingly abrupt change of the emission band. In each case the effect of various oxide concentrations was found to depend upon the concentration of the $SrCl_2$ flux. The distribution coeff. of the activators between SrS and SrO, the solubility of SrO in $SrCl_2$, and other solubility relationships largely determine the changes in the emission characteristics. In the continued search for simple luminescent systems, the investigation was extended to SrO phosphors. Anionic impurities and flux can be avoided and at least some of these phosphors exhibit the essential characteristics of the complex Lenard phosphors. Cu was found to act as an activator only if present in the univalent state. A.

535.371

174. The phosphorescence decay of halophosphates and other doubly activated phosphors. F. J. STUDER AND A. ROSENBAUM. *J. Opt. Soc. Amer.*, **39**, 685–9 (*Aug.*, 1949).

The decay rates of 3 doubly activated phosphors, namely, calcium halophosphate (Mn, Sb), calcium silicate (Mn, Pb) and zinc fluoride (Mn, Ti or W) have been investigated under $\lambda 2537$ excitation. The halophosphates studied all show initially a very rapid and abrupt decay, followed by a second stage of decay having a very slow rate. Both stages are of the exponential type. Investigation shows that the rapid rate (decay constant $\simeq 1\,500\ \text{sec}^{-1}$) is to be ascribed to the Sb emission and the slow rate ($k \simeq 75\ \text{sec}^{-1}$) to the Mn emission. Calcium silicate

behaves in a similar fashion, the ultraviolet emission due to Pb decaying rapidly ($k \simeq 480\ \text{sec}^{-1}$) and the visible more slowly ($k \simeq 60\ \text{sec}^{-1}$). The doubly activated zinc fluorides show similar behaviour, though the great spectral width of the W band makes separation of the 2 emission bands difficult. The fact that in all these cases the 2 activators each retain their characteristic decay rates in the presence of the other indicates that 2 types of centres exist in each of which the process of luminescence functions independently of the other. A.

535.371

175. Sodium and lithium as activators of fluorescence in zinc sulfide. F. A. KRÖGER. *J. Opt. Soc. Amer.*, **39**, 670–2 (*Aug.*, 1949).

Li and Na dissolved in ZnS act either as activators of fluorescence, or as quenchers, according to whether Cl is present or not. The fluorescence occurs only at low temps. and is excited by short-wave ultraviolet. The Li band has a max. at 4 380 Å in the sphalerite modification of ZnS; the Na band has a max. at 3 940 Å in sphalerite and at 3 800 Å in the wurtzite modification. The difference in the position of the bands for wurtzite and sphalerite and a shift found upon incorporation of CdS proves that one is dealing with electron-transfer bands. The centres of fluorescence are supposed to consist of Li or Na and Cl ions occupying normal lattice sites. The levels involved in the fluorescence transitions are levels due to lattice ions, changed by the presence of the monovalent ions (indirect activation). The quencher centres are supposed to consist of Li_2S and Na_2S incorporated in ZnS in such a way that the alkaline ions occupy two cation sites, while of two anion sites one is occupied by a monovalent S ion and the other by an electron. A.

535.371

176. Phosphorescent response to sinusoidal excitation. D. T. WILBER. *J. Opt. Soc. Amer.*, **39**, 673–4 (*Aug.*, 1949).

A mathematical study of the variation of brightness with time, of a theoretically exponential decay phosphor excited by a sinusoidal current as a function of the relative decay time and frequency of excitation, shows a phase lag and a decrease of amplitude of response increasing with the relative increase of decay time. The response is never sinusoidal and the increase in brightness is never as great as the decrease, which is characteristic of systems of a constant decay rate k involving the factor $K/(K + k)$. A.

535.371

177. The asymptotic behavior of spontaneous and forced decay. F. URBACH, N. R. NAIL AND D. PEARLMAN. *J. Opt. Soc. Amer.*, **39**, 675–80 (*Aug.*, 1949).

The decay of phosphors under the influence of stimulating radiation can be investigated in a manner which avoids some of the complications impairing the significance of most decay measurements. The stimulated decay of an infrared-sensitive strontium sulphide phosphor was measured. The complicating influence of spontaneous decay was practically eliminated. A phosphor with comparatively weak absorption of the stimulating and of the exciting radiation was selected and an extremely thin layer of the material was used, so that homogeneous excitation and stimulation were secured. The procedures of exhausting the phosphor and of measuring its stimulability were separated in principle and the stimulating intensity was kept constant throughout the exhaustion. The sensitivity to stimulation was measured over a range of 10^6, and the forced decay was carried to nearly complete exhaustion of the phosphor. This made it possible to determine the residual light-sum over a large range, and a region of very weak excitation of the phosphor was included. A further elimination of complicating factors is achieved by studying the infra-red-sensitivity as a function of the residual light-sum. The results of these measurements show strong evidence of second-order kinetics for the later stages of decay. A suggestion that a certain kind of superposition of second-order processes should lead to an exponential asymptotic behaviour of the decay is shown to be based on a fallacy. A.

535.371

178. Photometric evaluation of luminous materials for naval uses. W. S. PLYMALE, JR. AND L. H. DAWSON. *J. Opt. Soc. Amer.*, **39**, 712–13 (*Aug.*, 1949).

Types of luminous materials being used by the Navy are given in brief outline with some mention of particular application to problems arising under dark or near-dark conditions. The programme for improving low brightness photometry at the Naval Research Laboratory is explained with special attention given to physical photometry, utilizing photo-multiplier tubes. A.

535.371.07

179. The measurement of the luminescence of fluoroscopic X-ray screens. R. H. PECKHAM. *J. Opt. Soc. Amer.*, **39**, 714–17 (*Aug.*, 1949).

The selection of a superior fluoroscopic screen for direct X-ray observation and diagnosis requires the measurement of the visual effectiveness of the shadows of objects on the screen. At clinical levels of excitation ZnS–CdS fluoroscopic screens are excited to brightnesses near the condition of cone to rod transition. At these levels the colour and thickness of the screen becomes critical. A series of screens of various colours and thicknesses was examined, and the optimal colour and thickness were determined with the aid of an apparatus permitting psychometric technics. The selected screen provides cone stimulus in nearly all clinical situations. A.

535.372

180. The influence of temperature on the spectral energy distribution of some luminescent solids. C. C. VLAM. *Physica*, **15**, 609–23 (*Aug.*, 1949) *In English.*

Over the temp. range from 20–400°K the emission curves of $CaWO_4$ (with some $PbWO_4$) and $MgWO_4$ can be described by single Gaussian error functions. Peak frequencies and half intensity breadths increase linearly with temp. apart from a deviation of linearity at low temps. The spectral emission curve of Zn_2SiO_4 . 0·1 Mol % Mn_2SiO_4 (green emission) can be described by the sum of two Gauss equations. Of both bands the peak frequency decreases and the

half intensity breadth increases linearly with temp. between 20–400°K. The two bands appear to be correlated in such a way that the quotient of their half intensity breadths is independent of temp. Up to 200°K the energy emitted within each willemite band is constant with temp. In the range 200°–500°K the high frequency band increases whereas the low frequency band decreases in strength, their sum remaining nearly constant over the whole temp. range considered. A.

535.372

181. Temperature-dependent structure of the emission spectra of two crystalline forms of the zinc silicate: Mn phosphor. R. E. SHRADER. *J. Opt. Soc. Amer.*, **39**, 699–701 (*Aug.*, 1949).

The emission-spectra (excited by short ultraviolet) of 2 crystalline forms of the zinc-silicate : Mn phosphor have been recorded photographically. A number of operating temps. were used. The rhombohedral form, normally green-emitting, develops a yellow band at elevated temps. The high-temp.-quenched form, normally yellow-emitting, develops 2 green bands at lowered operating temps. Analysis indicates the possibility that the same bands are potentially present in both forms, but the effect of the different configurations is to emphasize different bands, especially with regard to their response to changes in temp. of operation. In addition to the "band" structure, "fine" structure was found for both forms at the lowest operating temp. (−196°C). A.

535.372

182. The emission spectrum of manganese-activated magnesium germanate. S. H. PATTEN AND F. E. WILLIAMS. *J. Opt. Soc. Amer.*, **39**, 702–4 (*Aug.*, 1949).

An unusual fine structure of emission has been reported for some Mn-activated Mg germanate phosphors. In order to determine the precise nature of the transitions involved, the temp. dependence of the actual intensities, half-widths and peak positions of the individual emission bands have been measured from −190°C to +90°C using ultraviolet excitation. The measurements were made in a constant temp. vacuum sample chamber and with a Littrow type spectrograph containing calibrated photographic plates. 5 emission bands were clearly resolved between 6 200 and 6 800 Å. The intensity of each band increases with temp. up to a critical temp. above which the efficiency decreases rapidly. Also, the short wavelength bands practically disappear at −190°C, and the individual bands shift slightly to shorter wavelengths and decrease in half-width at low temps. The experimental results are qualitatively interpreted, and tentative correlations with atomic spectra are proposed. A.

535.372

183. The emission characteristics of fluorescent pigments. C. E. BARNETT AND L. D. GRADY. *J. Opt. Soc. Amer.*, **39**, 663–9 (*Aug.*, 1949).

Emission spectra are shown for 5 pigments whose fluorescent colours are: blue, green, yellow, orange, and red. These are compared to reflectance spectra of paints tinted to approximate, in daylight, the fluorescent colours of the 5 pigments and to a series of standard artist's colours. The paper attempts to bring up to date practical information on the production of brightness with these phosphors. Following the general lines of development used by Kraehenbuehl and Chanon, data are given showing the relation between ultraviolet intensity and fluorescent brightness and between the latter and the masking effect of ambient illumination. The efficiency of light production from fluorescence excited by different types of commercial sources of near ultraviolet is described. A.

535.372

184. The luminescence of zinc sulfide activated by lead. N. W. SMIT AND F. A. KRÖGER. *J. Opt. Soc. Amer.*, **39**, 661–3 (*Aug.*, 1949).

ZnS activated by Pb shows fluorescence in various bands, 2 of which can be attributed to Pb. The first band has a max. at 4 850 Å, the second one at 6 100 Å. The orange band is favoured by sulphurizing conditions and appears irrespective of whether halide ions are present or not. This band is attributed to a characteristic electronic transition in divalent Pb ions, occupying normal lattice sites. The green band is favoured by reducing conditions and only appears when Cl ions are present. This band is attributed to electron transfer transitions between positive and negative ions of configurations formed by monovalent Pb and Cl ions, situated at normal lattice sites, together with the neighbouring lattice ions. A green band appearing in reduced ZnS is attributed to a stoichiometric excess of Zn. A.

535.372 : 537.52

Influence of discharge parameters on intensity of 1 850 and 2 537 Å lines in luminescent lamps. *See Abstr.* 286

535.375.03 : 545.823 : 535.89

A new source for Raman spectroscopy. *See Abstr.* 215

535.375.5

185. Influence of conjugation on intensity of Raman lines. M. HARRAND. *C.R. Acad. Sci., Paris*, **229**, 187–9 (*July* 18, 1949) *In French.*

The intensity of Raman lines varies with the substance: the object is to find the important causes. Materials having several unsaturated bonds seem to yield intense lines. Groups of substances are studied having a benzene nucleus and a linear chain, either saturated, ethylenic or acetylenic. The intensities of the Raman lines are compared with a convenient Rayleigh line. Styrolene and phenylacetylene have stronger lines than ethyl benzene. Propenylbenzene has stronger lines than alkylbenzene and propylbenzene. The line near 1 600 cm^{-1} is outstanding in this respect. A. C. G. MENZIES

535.375.5

186. Raman effect. Low frequency spectra of urea monocrystals. L. COUTURE-MATHIEU. *C.R. Acad. Sci., Paris*, **229**, 495–7 (*Aug.* 29, 1949) *In French.*

535.375.5

187. On the Raman spectra of CS_2 at different temperatures. N. C. MAJUMDAR. *Indian J. Phys.*, **23**, 253–7 (*June*, 1949).

It has been observed that the prominent Raman lines shift a little with the lowering of temp. Further, the wing which is observed to accompany the Rayleigh line at room temp. is much weakened at lower temps. and develops into a weak broad band at 45 cm^{-1} at

−100°C. In the case of the solid state this band is split up into 2 strong lines at 59 and 70 cm^{-1} at −125°C, which shift to 69 and 70 cm^{-3} respectively at −183°C. It is concluded that these results indicate the possibility of formation of dimers in the solid state, because the intensities of these lines do not diminish appreciably when the temp. of the solid is lowered. A.

535.375.5

188. Additivity of Raman spectra of dioxane–benzene mixtures. C. M. Richards and J. R. Nielsen. *Analyt. Chem.*, **21**, 1035–7 (*Sept.*, 1949).

Hanle and Heidenreich [*Z. Phys.*, **37**, 594 (1936)] have studied the intensities of the 835 cm^{-1} Raman band of dioxane and the 850 cm^{-1} band of benzene and have reported a striking deviation from additivity in mixtures of dioxane and benzene containing <10% of dioxane. The present report shows that this result may be attributed to the overlapping of the two bands and the presence of a faint dioxane band at 852 cm^{-1}. When correction is made for these effects, the Raman spectra are additive. A.

535.375.5 : 539.132

The vibrational frequencies of $CF_2{=}CH_2$. *See Abstr.* 415

535.375.5 : 548.7

189. Coupling of external oscillations in a crystal. L. Giulotto and G. Olivelli. Letter in *Nuovo Cim.*, **6**, 231–2 (*May*, 1949) *In Italian.*

The appearance of two low frequency lines in the Raman spectrum of calcite instead of one, was attributed to coupling between two vibrations—one of CO_3 ions translating perpendicularly to the optic axis, the other of CO_3 ions rotating round axes perpendicular to the optic axis. The latter is active in the Raman effect, and the coupling allows both to appear [see Abstr. 3712 (1948)]. By making assumptions concerning the forces between O atoms and Ca ions, the authors calculate the two low-frequency vibrations with electric vector parallel to the optic axis, to be expected in the i.r. spectrum, obtaining the necessary force-constants from the two Raman frequencies. A valence force model leads to calculated values 150 and 395, which they compare with the experimental values 106 and 357 cm^{-1}.

A. C. G. Menzies

535.376

190. Optical properties of calcium silicate phosphors. F. J. Studer and G. R. Fonda. *J. Opt. Soc. Amer.*, **39**, 655–60 (*Aug.*, 1949).

Calcium silicate phosphors activated with varying amounts of Mn luminesce yellow to orange under cathode-ray excitation, but are not excited by ultraviolet λ2537. If a small amount of Pb is added with the Mn, the resulting material responds to λ2537 to give the same colour as that produced by cathode rays, and in addition to the visible luminescence, there is an ultraviolet band at λ3400. The spectral distribution in the visible is dependent upon Mn concentration and on temp. If Pb alone is used as an activator, the product gives emission entirely in the ultraviolet. 3 emission bands are evident at approx. 3 000 Å, 3 340 Å and 3 500 Å, any one of which may be predominant, depending upon the conditions of preparation. The excitation spectrum also varies widely, having several max. between 2 000 Å and 3 000 Å. When the phosphor is excited by 2 288 Å line from a low-pressure Cd arc, a fourth broad band appears in the emission, which peaks about 3 850 Å and extends far enough to the longer wavelengths to be easily observed visually. X-ray analysis with a Geiger counter spectrometer demonstrates that the emission band at 3 000 Å is due to the α-metasilicate, the one at 3 500 Å to the β-metasilicate, while the 3 340 Å band is due to the β-orthosilicate. During the firing process the orthosilicate is formed first by the reaction between the calcium oxide and silica in equi-molar proportions, and it reacts thereafter with additional silica to form metasilicate. A.

535.376

191. A correlation between cathodoluminescence efficiency and decay as a function of temperature. R. H. Bube. *J. Opt. Soc. Amer.*, **39**, 681–4 (*Aug.*, 1949).—An investigation of the temp. variation of the cathodoluminescence efficiency of a Mn-activated ZnF_2 phosphor (tetragonal-ZnF_2 . 0·005 Mn) revealed a pronounced secondary increase in efficiency when the temp. was raised above 210° to about 330°C. This efficiency increase was accompanied by an intensity increase in the power-law-decay "tail" through that temp. range. The rapid emptying of traps at these temps., followed by radiative transitions of the freed electrons, can account for both observed results. Similar effects were found for a Mn-activated ZnS phosphor (hexagonal-ZnS . 0·018 Mn), and for a Cu-activated Zn–CdS phosphor (hexagonal-9ZnS . CdS . 0·0001 Cu). All measurements were made on Al-backed phosphor screens in sealed-off cathode-ray tubes. Decays were measured by photographing the output of a multiplier photo-tube as recorded on a d.c. oscilloscope. A.

535.376 : 537.527

192. Analogy between luminosity excited in rare gases by shock waves and discharge under pressure. H. Muraour. *C.R. Acad. Sci., Paris*, **228**, 1582–3 (*May* 16, 1949) *In French.*

Work on light excited by shock waves and that emitted by heavy current discharge through high-pressure rare gas tubes suggests that in both cases the emission indicated corresponds to hot body radiation. [See Abstr. 1864 (1948)]. J. Ewles

535.377

193. Thermoluminescence of manganese-activated zinc fluoride phosphors. J. S. Johnson, Jr. and F. E. Williams. *J. Opt. Soc. Amer.*, **39**, 709–11 (*Aug.*, 1949).

Thermoluminescence measurements at linear heating rates of 0·025 and 0·100°K/sec on the ZnF_2 : Mn phosphor with electron and ultraviolet excitation have been made as a function of activator concentration and crystallization temp. 5 individual glow peaks between 100°K and 700°K have been clearly resolved. The relative intensities and widths of the peaks are independent of the type of excitation and activator concentration but are strongly dependent on crystallization temps. and subsequent annealing. A detailed theoretical analysis of the glow peak at 350°K with the 0·025°K/sec heating rate indicates that the most

probable mechanism of the kinetics is basically first order with a strong probability of retrapping. The depths of the electron traps responsible for the complete thermoluminescence are estimated, and the possibilities of the precise physical nature of individual electron traps in ZnF_2 : Mn are discussed in the light of the glow data. A.

535.379

194. On the air afterglow. Y. TANAKA AND M. SHIMAZU. *J. Sci. Res. Inst. Tokyo*, **43**, 241–51 (*Aug.*, 1949).

Chemiluminescence was observed in the reactions between nitric oxide and activated oxygen or ozone. The colours of these flames were greenish-yellow and reddish-yellow, respectively. The spectra of both were composed of continuum and diffuse bands, but the intensity distributions differed. These were compared with the spectrum of the so-called air afterglow. It seems likely that the air afterglow is produced by the reaction between nitric oxide and activated oxygen, but clear explanation is still lacking for the mechanism of this reaction. A.

535.39

195. Surface improvement of photographic lenses. S. BUCH. *Z. wiss. Photogr.*, **44** (*Nos* 1–7) 124–33 (1949) *In German.*

An elementary review of the surface treatment of lenses. Describes briefly the known methods of producing films. H. H. HOPKINS

535.39

196. Interference in films (including films produced by corrosion) on metal mirrors. K. STEINBUCH. *Z. angew. Phys.*, **1**, 256–60 (*Jan.*, 1949) *In German.*

A theoretical treatment on orthodox electromagnetic grounds of reflection from a plane metal surface with two parallel-sided films, leading to conditions for min. and max. reflecting factor. N. CORCORAN

535.39

197. The optical constants of thin metallic films. R. WEALE. *Proc. Phys. Soc., Lond. B*, **62**, 576–8 (*Sept.*, 1949).

These are shown to depend on the thickness of the films due to the variation of the electrical conductivity with thickness. Good and bad conductors both exhibit maxima in the curves relating absorption coeff. and film thickness: in the two groups these peaks are due to two entirely different causes. The mean free paths of the conducting electrons are calculated from data found in the literature. A.

535.39 : 535.361.2

198. The diffuse reflectivity of oxide layers formed on steels under defined conditions. R. J. DONATO. *Proc. Phys. Soc., Lond. B*, **62**, 629–38 (*Oct.*, 1949).

A method to determine the reflectivity at various wavelengths in the visible spectrum and at temps. up to 660°C is described. An integrating sphere is used in which the specimen replaces a portion of the sphere wall, and a method is given for the simultaneous comparison of two beams of light using a single photocathode. Except for a correction factor depending upon the geometry of the sphere, the measurements rely solely upon the area of an adjustable aperture. Some results are given for the oxides of various steels. A.

535.412 : 533.6.011.5

199. Identification of fringes in interferograms for gaseous flow. J. DUPUY. *C.R. Acad. Sci., Paris*, **229**, 29–30 (*July* 4, 1949) *In French.*

Describes the application of a Mach interferometer, 1½ m long, with 2 separators 85 mm in diameter, to measure gaseous flow in the supersonic wind-tunnel at Grenoble. With white light the central fringe is clearly identified, and dichromatic fringes are used at the same time with a beating period of 6½ fringes or of 4 fringes. A. C. G. MENZIES

535.417 : 539.536

200. Interferometric examination of hardness test indentations. S. TOLANSKY AND D. G. NICKOLS. *Nature, Lond.*, **164**, 103–4 (*July* 16, 1949).

By means of multiple-beam interferometry the distortions produced on metal surfaces by pyramid and cone diamond indenters are studied. Observations are reported for sintered tungsten carbide, a Cr/Ni/Mo alloy and a typical silver steel. The nature and extent of the surface "piling-up" is revealed. S. TOLANSKY

535.421

201. A new spectrographic diffraction grating mounting. A. H. C. P. GILLIESON. *J. Sci. Instrum. Phys. Ind.*, **26**, 335–9 (*Oct.*, 1949).

A design of spectrograph mounting, novel in that convergent light falls on a plane grating, has been investigated theoretically and practically. The focal curve can be made flatter than that of the two existing mountings, the Rowland circle or the Wadsworth, the astigmatism can be made zero at one point on the plate and very slight elsewhere on the plate, and the dispersion, whilst less uniform than that of the Eagle (Rowland Circle), is more uniform than that of the Wadsworth mounting. Like the Wadsworth mounting, operation can be limited to two focusing controls, but this new mounting is more compact and has no heavy moving parts. A.

535.421

202. Optical diffraction patterns produced by bubble rafts. J. DYSON. *Proc. Roy. Soc. A*, **199**, 130–9 (*Oct.* 7, 1949).

A method of obtaining diffraction patterns, analogous to X-ray and electron diffraction patterns, from photographs of bubble rafts is described. The results of some early experiments are shown, and the conditions for obtaining patterns of higher resolution and more uniform illumination are deduced. An experimental technique for realizing these conditions is described and the results are shown. A method is described for viewing the raft in the light of a selected region of the diffraction pattern, and some results of this technique are shown. A.

535.434 : 541.182.3

Light scattering as a measure of particle size in aerosols. The production of monodisperse crystals. *See Abstr.* 568

535.436 : 551.521.3

203. An observation of non-Rayleigh scattering of the infrared solar spectrum by the earth's atmosphere. A. ADEL. Letter in *Phys. Rev.*, **76**, 446–7 (*Aug.* 1, 1949).

Comparison of sky-scattered with direct sunlight (from 4° out to 8° from sun) in the wavelength interval,

1 μ to 4 μ, reveals marked departure from Rayleigh distribution, and suggests an inverse first power, rather than inverse fourth power, dependence on wavelength. D. R. BARBER

535.436 : 551.593.5

204. Scattered radiation due to atmospheric fog and secondary diffusion. F. MÖLLER. *Met. Rdsch.*, **1**, 212–15 (*Jan.–Feb.*, 1948) *In German.*

By comparing the measured distribution of the scattered radiation in a hazy and dusty atmosphere with the theory of the scatter of light by small particles, it has been found that the majority of the small droplets in the atmosphere have radii of about 10^{-4} mm. This agrees with the size generally accepted for the particles forming the nuclei of condensation for the saturated vapour contained in the air. The bigger dust particles thus do not seem to have an influence on the distribution of the scattered radiation. To make sure that the measured values of this distribution are not affected by secondary diffusion, a calculation was carried out which showed that secondary diffusion has only a minor influence on the distribution of the scattered radiation, thus indicating that the above conclusions are basically correct.

APPLIED MECHANICS REVIEWS

535.513

205. Concerning the propagation of radiation in birefringent media. E. CERASOLI. *Atti Fond.* "*Giorgio Ronchi*," **4**, 30–2 (*Feb.–April*, 1949) *In Italian.*

Shows how to determine the vibration directions of the two plane polarized waves which can be propagated unaltered in a doubly refracting crystal. It is shown that these two waves cannot derive from the same incident wave. H. H. HOPKINS

535.514.9

206. Some experiments with polarizing films in the ultra-violet. R. BARER. *J. Sci. Instrum. Phys. Ind.*, **26**, 325–7 (*Oct.*, 1949).

The properties of new forms of polarizing films in the ultra-violet are discussed. One variety shows a very high degree of polarization from 270 mμ in the ultraviolet, extending throughout the visible region. A transmission band exists below 270 mμ. The possibility thus exists of using such films either as polarizers or as filters. They may also be employed for the construction of ultraviolet polarization-interference filters. Two crossed films act as a very efficient filter for the near infrared region (1–3 μ). A.

535.55

207. Photoelastic analysis. M. KANTOLA. *Tied. Valt. Tekn. Tutkimuslaitos* (*No.* 69) 3–11 (1948) *In Finnish.*

Discusses photoelastic phenomenon and gives an account of the origin of the isochromatic and isoclinic lines. At the same time the importance of the $\lambda/4$ retardation plate in the removal of the isoclinic lines when there is a question of observation of only the isochromatic lines is explained. A brief explanation is given of the determination of the stress distribution in models. Finally, the set of apparatus in the Laboratory for Technical Physics of the State Institute for Technical Research (Finland) for the study of photoelastic analysis, is described. In this apparatus the analyser and polarizer are "polaroid" plates, size 6×6 in. The $\lambda/4$ retardation plates are made of plexi-sheet by the "freezing" method. A.

535.55

208. A method of assessing transient stresses in photoelastic substances. J. S. STANTON. *Rev. Sci. Instrum.*, **20**, 139 (*Feb.*, 1949).

A combination of the techniques of static photo-elasticity and of the spark shadowgraph is used, in which shadow pictures of the model illuminated by plane-polarized light are photographed. The possibility of extension beyond the elastic limit is mentioned.

H. G. JERRARD

535.551 : 539.4

209. The similarity and model laws in photo-elastic experiments. E. MÖNCH. *Z. angew. Phys.*, **1**, 306–16 (*March*, 1949) *In German.*

In addition to the fundamental laws of geometrical similarity and similarity of forces, Hooke's general law of similarity and Poisson's model law must hold when static photo-elastic experiments are considered. These last two laws are discussed. Hooke's law and Poisson's law require equal changes in shape and equal Poisson's ratio respectively in the actual structure and in the model. In practice in order to get accuracy of measurement one uses a larger variation in shape than is theoretically demanded. This "extended similarity" is, in most cases, permissible but introduces a new scale. This scale and the application of extended similarity to the special problems of contact of curved bodies, plane state of stress, bending of plates and plane bending are fully discussed. The fact that one works with extended similarity and not rigorous similarity and often does not obey Poisson's law gives errors in the results which are described and estimated. H. G. JERRARD

535.565

210. Action of a longitudinal electric field on the rotatory power of a Rochelle salt crystal. M. LÉVY. *C.R. Acad. Sci., Paris*, **228**, 1000–2 (*March* 21, 1949) *In French.*

A brief note reporting preliminary measurements on the effect of temp. and electrical field on the rotatory power of Rochelle salt. The observed variations due to the electric field are in accord with theory.

H. J. H. STARKS

535.566 : 541.64

The use of polarized infra-red radiation in the study of doubly oriented long-chain polymers. *See Abstr.* 575

535.566.2

211. Physical properties of solutions of camphor in carbon tetrachloride. J.-C. PARIAUD. *C.R. Acad. Sci., Paris*, **228**, 563–5 (*Feb.* 14, 1949) *In French.*

The specific rotation decreases with concentration. There is a eutectic corresponding to 1 molecule of camphor to 2 of CCl_4, and having a f.p. of $-14{\cdot}5$°C.

N. CORCORAN

535.65

212. On the specification of luminous sources by the method of spectral ranges. Y. LE GRAND. *C.R. Acad. Sci., Paris*, **228**, 672–4 (*Feb.* 21, 1949) *In French.*

The C.I.E. ranges are rejected as the extreme bands hardly contribute to the specification, and the distribution of the colour ordinates is irregular. An improved

system is compared with the standard in two tables. Its advantage lies in its more restricted spectral range, and in its applicability to pigments. R. A. WEALE

535.82

213. Some results and prospects in the application of luminescent microscopy to biology. M. N. MEISEL. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13** (*No.* 2) 230–6 (1949) *In Russian.*

Description of a new type of opaque-illuminator and of a new u.v. light-cum-luminescence microscope constructed in the U.S.S.R. The use of luminescence microscopy for the examination of some dyes, hormones and vitamins is emphasized. The new technique of using fluorochromes is described in some detail. F. LACHMAN

535.83 : 522.2

Some recent applications of optics and astronomy. *See Abstr.* 6

535.862

214. Addendum: Transmission of light from diffuse sources by periscope tubes. F. P. BUNDY AND H. M. STRONG. *J. Opt. Soc. Amer.*, **39**, 698 (*Aug.*, 1949).

See Abstr. 4716 (1949).

535.89 : 535.375.03 : 545.823

215. A new source for Raman spectroscopy. A. C. MENZIES AND J. SKINNER. *J. Sci. Instrum. Phys. Ind.*, **26** 299–30 (*Sept.*, 1949).

A straight glass tube holding 6 ml of gas is illuminated by 4 Hg vapour lamps placed symmetrically round it, the whole being surrounded by MgO diffuse reflecting surface. Co-axial sleeves for cooling water and filtering fluids are provided. The scattered light emerges from the end of the tube. The source is intended for industrial analysis use.

HEAT 536

536.2.01/.02 : 517.947.43

216. On a solution of Fourier's equation. M. AUBERT. *C.R. Acad. Sci., Paris*, **228**, 816–17 (*March* 7, 1949) *In French.*

It is shown by using the substitution $f' = e^{-z^2}p(z)$ that the polynomials, R, satisfying Ribaud's equation [Abstr. 203, 204 (1949)], and Hermite's polynomials, H, are related by $R_{2m}(z) = H_{-2m}(iz)$ where $2m$ is a positive integer. A series expression for R is thus derived. S. WEINTROUB

536.212.3 : 666

217. Thermal conductivity of glasses at low temperatures. R. BERMAN. *Phys. Rev.*, **76**, 315–16 (*July* 15, 1949).

Continuous curves of the variation of the heat conductivity with temp. in the range 2°K to 90°K have been obtained for quartz and phoenix glass. Curves show that, at lower temps., the heat conductivity of quartz glass does not fall as rapidly as the specific heat. This is attributed to the mean free path of the heat waves increasing with decreasing temp., which is illustrated by a curve (calculated from the above results) of the variation of this mean free path with temp. from 2°K to 90°K. In contrast, for a rod of micro-crystalline graphite (where the mean free path is limited by the grain size) the heat conductivity at 1°K has been found to be about 50 times <, and at 90°K to be about 80 times > that of glass. W. H. DENTON

536.222

218. Thermal conductivity of liquid silicones. O. K. BATES. *Industr. Engng Chem.*, **41**, 1966–8 (*Sept.*, 1949).

The thermal conductivity and coeff. of thermal conductivity for 9 liquid silicones of the homologous series of pure trimethyl end-blocked dimethyl siloxanes, ranging in viscosities from 0·65 to 12 500 cs at 25°C, were determined experimentally. An empirical equation, relating the thermal conductivity as a function of the viscosity and temperature, is proposed for this series of polymers. A.

536.24

219. On the application of Reynolds' analogy and the heat-exchange factor to the design of heat exchangers. I–III. B. H. SCHULTZ. *Appl. Sci. Res.*, **A 1** (*Nos* 5–6) 387–416 (1949).

Reynolds' analogy between heat transfer and friction leads to the well-known equation $h = \frac{1}{2}fc_p\rho v$. According to improved theories, for turbulent flow of gases in long straight ducts, the factor $\frac{1}{2}$ is to be replaced by $c = 0{\cdot}55$. It is shown that for laminar flow in long ducts $c = 0{\cdot}3$ for a circular, and $0{\cdot}4$ for a flat rectangular cross-section. Further in very short ducts an approximate theory is shown to give values that are of the same order of magnitude. Though the equation $h = cfc_p\rho v$ has an approximate character, it has the advantage of being simple and generally valid for gases flowing in ducts. For heat exchangers in which the temp. differences between gas and wall decrease considerably it proves to be useful to introduce a "heat-exchange factor" K. A simple relation between K and the pressure drop can be derived from the modified form of Reynolds' analogy given in Part I. This relation is applied to some problems of optimum dimensions for heat exchangers. The value of c in the relation between K and the pressure drop for turbulent flow is taken from the experimental data given in the literature. Measurements in the transition region show that, though both heat exchange and friction may vary considerably with changing flow conditions at (or before) the entrance of the ducts, the factor c does not vary appreciably. In those cases where the curve for f shows a pronounced "dip" this is also found in the curve for the heat-exchange factor. A.

536.24 : 532.525

Transfer of heat in an axially symmetrical jet. *See Abstr.* 80

536.242

220. Heat transfer at high rates to water with surface boiling. W. H. MCADAMS, W. E. KENNEL, C. S. MINDEN, R. CARL, P. M. PICORNELL AND J. E. DEW. *Industr. Engng Chem.*, **41**, 1945–53 (*Sept.*, 1949).

A study of heat transfer at high density of heat flux from an electrically heated surface to water flowing in annuli. Gives quantitative relations between density of heat flux, temp. difference, pressure, degree of subcooling, and water velocity.

Degassed distilled water flowed upward through a vertical glass tube, containing a centrally located heater having an outside diameter of 0·25 in. A.

536.242

221. Heat transfer to water at high flux densities with and without surface boiling. F. KREITH AND M. SUMMERFIELD. *Trans. Amer. Soc. Mech. Engrs*, **71**, 805–15 (*Oct.*, 1949).

Surface coeffs. of heat transfer have been obtained at rates of heat flux up to 3 B.T.U./in² sec for water flowing in stainless steel tubes at mass-flow rates up to 5·4 lb/in² sec. The non-boiling forced-convection data were correlated by the Colborn eqn. $Nu_f = 0{\cdot}023\ Re_f^{0{\cdot}8} . Pr_f^{\frac{1}{3}}$ within ± 5%, but with surface boiling, considerably larger *Nu* moduli were observed. When surface boiling occurred, the wall temp. was determined primarily by the pressure, being rel. insensitive to variations in rel. heat flux, and bulk temp. The max. heat flux that could be removed was limited by an unsteady flow phenomenon. Data for pressure drop are presented and correlated by an empirical viscosity correction factor. A.

536.244

222. Effective thermal conductivities in gas-solid systems. D. G. BUNNELL, H. B. IRVIN, R. W. OLSON AND J. M. SMITH. *Industr. Engng Chem.*, **41**, 1977–81 (*Sept.*, 1949).

Point to point temperatures have been measured for both the solid and gas in a 2 in reactor, packed with 0·125 in alumina cylinders, and through which hot air was passed at mass velocities from 150 to 500 lb/hr ft². A.

536.4.031

223. The subcooling of liquid metals. D. TURNBULL, Letter in *J. Appl. Phys.*, **20**, 817 (*Aug.*, 1949).

Results of observations on the rate of solidification of aggregates of Hg and Ga droplets are given. The transformations were followed dilatometrically using alcohol as indicator. For Hg aggregates prepared by dispersing Hg in solutions of sodium oleate in alcohol no measurable transformation occurred until 33° below T_m (m.p.), becoming rapid at 39° below, and for aggregates prepared by dispersal in solutions of I in alcohol until 43°, and at 46°, respectively. For Ga aggregates in the former solution the rate of solidification did not become appreciable until 70° below T_m. The max. supercooling, T, obtained for bulk, and aggregates of small droplets of Sn, Hg and Ga, are compared, and T/T_m is shown to be approx. constant. S. WEINTROUB

536.422

224. Vaporization of liquids in closed vessels. II. V. A. IOFFE, E. V. KUVSHINSKIĬ AND N. M. REĬNOV. *J. Tech. Phys., USSR*, **18**, 341–4 (*March*, 1948) *In Russian.*

The kinetics of the vaporization of benzol and CCl_4 in an atmosphere of SF_6 in a closed vessel were studied. B. F. KRAUS

536.423

225. Condensation and frost formation during free convection. K. FENIGER. *Bull. Int. Inst. Refrig.*, **29** (*No.* 5) *A*39–47 (1948) *In English.*

A brief theoretical discussion of the condensation of water vapour on a cold surface at a temp. above 0°C, taking into account the air flow over the surface and the heat flows by free convection and condensation, is given, quoting work by the author and others. A nomogram for the determination of the mean temp. of the thermal boundary layer in terms of the temps. of the surface and of the moist air distant from the surface is given. For frost formation on surfaces below 0°C it is pointed out that tests made do not confirm a constant relation between free convection and the diffusion of water vapour into the air. The porosity of the frost is an important factor to be considered [Abstr. 982 (1949)]. The variation in density as a function of time is shown graphically, and a nomogram for computing the ratio between free convection and water vapour of the air is given. S. WEINTROUB

536.46

226. A study of laboratory Bunsen burners for natural gas. J. H. EISEMAN. *J. Res. Nat. Bur. Stand., Wash.*, **42**, 541–56 (*June*, 1949).

16 different laboratory-type Bunsen burners, sold as suitable for natural gas, were purchased and their limits of operation determined. 8 of the burners were of the Meker type, and 8 were straight-tube burners. The results of the study indicate the need for certain changes in design if satisfactory operating characteristics are to be obtained with natural gas. A.

536.46

227. Structure and stability of burner flames. N. THOMAS. *Trans. Faraday Soc.*, **45**, 781–94 (*June*, 1949).

An attempt is made to develop a general theory of flame stability in stationary flames based on the assumption of steady-state heat balance. The heat balance equation for the flame is formulated, and approx. solutions obtained under certain specified conditions. Certain experimental phenomena involving the stability limits of flames can be explained semi-quantitatively by this theory. It does not, however, take into account the chemical kinetics of the reactions, or aerodynamic effects which are of importance in dealing with high-velocity flames. A.

536.46

228. Photoelectric measurements on cool flames. L. OUELLET, E. LEGER AND C. OUELLET. Letter in *J. Chem. Phys.*, **17**, 746–7 (*Aug.*, 1949).

Mixtures are quickly admitted to a preheated vessel and light intensity is traced against time with a c.r.o. An induction period and sharp initial rise is followed by two or more maxima before decay. Relative intensities are obtained for various fuels, and effect of pressure, temp., vessel diameter and diluents are examined. HCHO and NO increase the induction period. Pb ethyl and HCHO quench the light. A. G. GAYDON

536.46 : 541.126

229. A study of the laws of combustion of colloidal powders. Comments on the law: $V = a + bP$. H. MURAOUR AND G. AUNIS. *C.R. Acad. Sci., Paris*, **228**, 818–20 (*March* 7, 1949) *In French.*

[V is the velocity of combustion, P the pressure, log b is a linear function of the temp. T°K of the

explosion]. The authors state that they have shown that the variation of a with T is small, and that consequently a arises from energy contributed by conduction, which is independent of P and $\propto$ time. By considering the 3 phases into which the decomposition of colloidal powders with ethyl nitrate base can be divided, another explanation, depending on the hypothesis that the temp. of the gases liberated by the powders is a function of P, is given for the presence of a in the law. S. WEINTROUB

536.48

230. On the thermodynamics of the two fluid model of helium II. C. J. GORTER. *Physica*, **15**, 523–31 (*July*, 1949) *In English.*

It is shown that the conclusions usually drawn from this model are only valid if special expressions for Gibbs' function of the liquid are accepted. A.

536.48

231. The hydrodynamics of helium II. R. B. DINGLE. *Proc. Phys. Soc., Lond. A*, **62**, 648–55 (*Oct.*, 1949).

Expressions are derived for the forces acting on the normal fluid and on the superfluid of He II, and it is shown that the apparently differing derivations of the velocity of second sound given by Landau and Tisza are, in fact, equivalent, even if thermal expansion is not neglected. A.

536.48 : 536.631 : 539.152.2

A possible nuclear effect in magnetic cooling experiments on copper salts. *See Abstr.* 434

536.48 : 538.224

Magnetic susceptibility of zinc at liquid hydrogen temperatures. *See Abstr.* 382

536.5.081

232. Determination of very low thermodynamic temperatures in chromium potassium alum. D. DE KLERK, M. J. STEENLAND AND C. J. GORTER. *Physica*, **15**, 649–66 (*Aug.*, 1949) *In English.*

Thermodynamic temps. have been measured in the region below 0·1°K by 4 different methods. The results are in reasonable agreement. Hysteresis sets in at 0·004°K. The lowest temps. measured are around 0·003°K. The susceptibility and the losses are given at a frequency of 225 c/s. At the higher temps. the losses are $\propto \nu^{1\cdot7\pm0\cdot15}$ between 225 and 525 c/s. A.

536.532

233. Some observations on the behaviour of platinum–platinum/rhodium thermocouples at high temperatures. M. K. MCQUILLAN. *J. Sci. Instrum. Phys. Ind.*, **26**, 329–31 (*Oct.*, 1949).

It has been found that in air more Pt than Rh is lost by preferential oxidation, and *in vacuo*, by volatilization. Very little metal is lost on heating in H. An explanation of those effects hitherto explained by loss of Rh has been suggested. The effect of heating Pt wires in a reducing atmosphere in the presence of refractory materials other than those containing Si has also been investigated. C, beryllia and alumina have been found to have no contaminating effect. No appreciable change in the thermal e.m.f. developed at 950°C has been observed in thermocouples heated in H for 12 hr at 1 600°C. A.

536.55 : 533.6.08

A method for the instantaneous measurement of temperature in high speed air flow. *See Abstr.* 93

536.655 : 532.13

The correlation between viscosity and energy of vaporization. *See Abstr.* 72

536.655

234. Results of low temperature investigations. VI. Calorimetric measurements of the latent heat of vaporization of oxygen at normal pressure and of ethylene and propylene above and below atmospheric pressure. K. CLUSIUS AND F. KONNERTZ. *Z. Naturforsch.*, **4a**, 117–24 (*May*, 1949) *In German.*

Experimental values of latent heats for ethylene from 0·157 to 25·5 atms. (143·4 to 254°K) and for propylene from 0·173 to 8·85 atm (193·1 to 288·4°K). F. E. HOARE

536.655

235. The heats of vaporization of uranium hexafluoride. J. F. MASI. *J. Chem. Phys.*, **17**, 755–8 (*Sept.*, 1949).

Vaporizations of UF_6 were carried out in a heavy-wall, nickel-plated calorimeter. Measurements of the heat of vaporization of the solid were made at 7 temps. and of the liquid at 4 temps., covering the range from 4° to 90°C. The apparatus was tested before beginning the measurements by obtaining the heats of vaporization of water at 3 temps. The scattering of the data on $UF_6 \simeq 1\%$. The measured heats of vaporization have been used to obtain a consistent correlation of the vapour pressures, heat of fusion, and triple point given in the literature. The results are expressed as vapour pressure equations and an equation of state for the saturated vapour. From these equations and the N.B.S. values for the thermodynamic properties of the solid and liquid, the entropies of the ideal gas are calculated and compared with those given in the literature from spectroscopic data and molecular structure. A.

536.656

236. Evolution of heat during precipitation in lead-tin alloys. J. NYSTRÖM. *Ark. Fys.*, **1**, *Paper* 18, 359–67 (1949) *In English.*

The rapid transformations in the Pb–Sn system were followed by using specimens in the form of wire of 0·7–1·6 mm dia. Uniformity was judged by elec. resistance measurements over different portions. The specimen was supported axially in a hollow cylindrical Cu block 20 cm long by 4 cm dia. Current could be passed through the wire from end to end, or through a central portion, and constantan-manganin thermocouples wound round the specimen over a layer of silicone varnish gave temp. difference between the wire and block. The apparatus was used in a vapour thermostat with water or bromo-benzene, or in an ice-bath. To homogenize the specimen an electric current was passed for 10 hr. The thermocouple galvanometer deflections were plotted against time and showed that the specimen first attained the temp. of the thermostat, but, when precipitation started the temp. rose again, and the heat produced could be calculated from the experimental data. The two-phase boundary was extrapolated to low concentrations of Sn, and the evolution of heat in

the system was calculated. The form of the power curves is discussed in relation to the transformation velocity. Precipitation occurred in 2 stages. At 6 and 9% Sn the second stage was too slow to be detected during the measurements, but at 12–13% Sn both stages could be followed. It is suggested that the first stage of transformation is the formation of nuclei, which grow to a precipitate later.

W. ASHWORTH

536.662

237. The heats of combustion of polythene and polyisobutylene. G. S. PARKS AND J. R. MOSLEY. *J. Chem. Phys.*, **17**, 691–4 (*Aug.*, 1949).

THERMODYNAMICS 536.7/.8

536.7

238. On the thermodynamics of irreversible processes. J. E. VERSCHAFFELT. *Physica*, **15**, 489–502 (*July*, 1949) *In French.*

The thermodynamical problem of diffusion is treated by the application of the fundamental laws of energy and entropy making use of the additional principle of superposition. The results are in agreement with the reciprocity principle of Onsager.

F. E. HOARE

536.7 : 530.12

On the thermodynamical equilibrium of fluids in gravitational fields. *See Abstr.* 43.

536.71

239. Thermodynamical functions of a nitrogen-hydrogen mixture between 0°C and 300°C up to 1 000 atmospheres. A. MICHELS, S. R. DE GROOT AND R. J. LUNBECK. *Appl. Sci. Res.*, **A 1** (*Nos* 5–6) 378–86 (1949).

Thermodynamical functions of a 1 : 3 N–H mixture are given at the temperatures 0°, 25°, 50°, 75°, 100°, 125° and 150°C up to pressures of 1 000 atmos. for integral values of pressure. A.

536.77

240. A method for the accurate calculation of some thermodynamic properties of non-polar or moderately polar substances, based on Van Laar's theory. W. HEUKELOM. *Rec. Trav. Chim. Pays. Bas*, **68**, 661–98 (*Sept.–Oct.*, 1949) *In English.*

Van Laar's method to calculate the critical conditions is based on the molecular constants a and b in van der Waals' equation of state. In certain cases inaccuracies in the calculated values of a may lead to results which deviate considerably from the experiment. It is demonstrated that the accuracy may be increased to a considerable extent by replacing the constant a in the calculations by less fundamental magnitudes, such as the boiling point and the vapour tension factor. It is found that in the latter case the probable error $\sim$ the experimental error. An extensive survey is given of the results for several substances of different structural types. A brief survey is given of some further data which can be calculated from the results obtained. A.

ELECTRICITY 537

537.081.1 : 621.3.081.1

241. Establishment and maintenance of the electrical units. F. B. SILSBEE. *Circ. U.S. Nat. Bur. Stand.* (*No.* 475) 38 *pp.* (1949).

A history of the establishment of the "international" system of electrical units, its operation during 1911–47 and of the developments that caused it to be superseded. It includes a record of the international comparisons, which indicated that the units of some countries have at times drifted nearly 0·01% from the mean, an account of the maintenance procedures used at the National Bureau of Standards and brief descriptions of the methods currently available for the absolute measurement of resistance and of current, which will be used in the future as a check on the maintenance of the units. A.

THEORY . ELECTRONS 537.1

537.12 : 538.3

242. On a new conception of the interaction between charges and electromagnetic field. L. DE BROGLIE. Letter in *Phys. Rev.*, **76**, 862–3 (*Sept.* 15, 1949).

The many-time theory is interpreted in terms of an extended source model of the electron, in the sense that the elimination from the equations of all the interaction fields except that of the photon is equivalent to replacing a point charge by such a source. The relation to some previous work by the author is discussed. G. J. KYNCH

537.122 : 530.145

On the spin and the structure of the electron. *See Abstr.* 51

537.132 : 530.145.6

243. The theory of positrons. R. P. FEYNMAN. *Phys. Rev.*, **76**, 749–59 (*Sept.* 15, 1949).

The problem of the behaviour of positrons and electrons in given external potentials, neglecting their mutual interaction, is analysed by replacing the theory of holes by a reinterpretation of the solutions of the Dirac equation. It is possible to write down a complete solution of the problem in terms of boundary conditions on the wave functions, and this solution contains automatically all the possibilities of virtual (and real) pair formation and annihilation together with the ordinary scattering processes, including the correct relative signs of the various terms. In this solution, the "negative energy states" appear in a form which may be pictured (as by Stückelberg) in space-time as waves travelling away from the external potential backwards in time. Experimentally, such a wave corresponds to a positron approaching the potential and annihilating the electron. A particle moving forward in time (electron) in a potential may be scattered forward in time (ordinary scattering) or backward (pair annihilation). When moving backward (positron) it may be scattered backward in time (positron scattering) or forward (pair production). For such a particle the amplitude for transition from an initial to a final state is analysed to any order in

the potential by considering it to undergo a sequence of such scatterings. The amplitude for a process involving many such particles is the product of the transition amplitudes for each particle. The exclusion principle requires that antisymmetric combinations of amplitudes be chosen for those complete processes which differ only by exchange of particles. It seems that a consistent interpretation is only possible if the exclusion principle is adopted. The exclusion principle need not be taken into account in intermediate states. Vacuum problems do not arise for charges which do not interact with one another, but these are analysed nevertheless in anticipation of application to quantum electrodynamics. The results are also expressed in momentum-energy variables. Equivalence to the second quantization theory of holes is proved in an appendix. A.

537.133 : 538.566.2

Wave amplification by interaction with a stream of electrons. *See Abstr.* 398

537.133 : 539.185

Polarization effects in n–p and p–p scattering. *See Abstr.* 526

ELECTROSTATICS . DIELECTRICS 537.2

537.22

244. Ice electricity. A. Becker and I. Schaper. *Z. Naturforsch.*, **4a**, 194–8 (*June*, 1949) *In German.*

The fusion of ice in an electrical field is accompanied by the appearance of electrical charges which are conveyed by charged particles into the surrounding atmosphere. Full experimental details are included in the paper for this new electrical effect.

H. H. HODGSON

537.226

245. A contribution to the theory of the dielectric constant of polar liquids. T. G. Scholte. *Physica*, **15**, 437–49 (*July* 1949) *In English.*

Some simplifications used in Onsager's theory on the permittivity of pure liquids are considered. At first, instead of a spherical, an ellipsoidal shape of the molecules is attempted and the cavity field and reaction field of a dipole are computed in this case. It appears that the reaction field of a dipole in an ellipsoidal cavity is $<$ the reaction field in a spherical cavity of the same volume if the longest axis is in the direction of the dipole. In the case that the shortest axis is in the direction of the dipole, the reaction field is $>$ in a spherical cavity. A discussion on the radius of the cavity is also given. A model is assumed in which for the polarizability effects the continuous environment begins at a distance equal to the radius of the molecules while for the influence of the dipolar interaction the continuous environment begins at twice this distance. A.

537.226

246. Dielectric relaxation of molecules containing rotating polar groups. A. Budó. *J. Chem. Phys.*, **17**, 686–91 (*Aug.*, 1949).

Debye's theory of dielectric relaxation has been extended to molecules consisting of two similar polar groups, which cannot rotate freely relatively to one another owing to their mutual potential energy. As a result, the mean dipole moment of the molecule in the field $F_0 \exp(i\omega t)$ can be expressed by a sum of terms of Debye's type, namely $C_\lambda/(1 + i\omega\tau_\lambda)$, where the relaxation times τ_λ and the constants C_λ are determined by an eigenvalue problem. τ_λ and C_λ are calculated in the case of the cosine coupling between the groups and in the case of the quasi-elastic bond. The results are compared with the experimental data for chloro-derivatives of diphenyl. A.

537.226 : 539.133

247. The calculation of the polarisabilities, molecular radii and dipole moments of some organic liquids. T. G. Scholte. *Physica* **15**, 450–8 (*July* 1949) *In English.*

With the aid of Onsager's theory and an extension of it for molecular shape and radius of the cavity, the polarizabilities, molecular radii and dipole moments of some organic molecules are computed from data of the pure liquids. The dipole moments agree well with those computed from gas data. A.

537.226 : 548.7

248. An extension of the theory of Mason and Matthias to the low temperature transitions in $BaTiO_3$. H. J. Wellard. Letter in *Phys. Rev.*, **76**, 565 (*Aug.* 15, 1949).

Expressions for the permanent polarization P previously derived [Abstr. 2492 (1949)] are treated more exactly. The critical temp. for the existence of P_y together with P_z and also the temp. below which polarizations $P_x = P_y = P_z \neq 0$ can exist are calculated (approx. 275°K and 180°K resp.). Slight departures from these symmetrical conditions may be present in real crystals, as experiments confirm.

A. L. MACKAY

537.226 : 548.7

249. Properties of barium titanate in connection with its crystal structure. G. H. Jonker and J. H. van Santen. *Science*, **109**, 632–5 (*June* 24, 1949).

High polarizability above the Curie point is attributed to the high refractive index, the loose geometrical fit of the Ti ions in the O octahedra and the unusually high correction to be applied to the Clausius–Mosotti equation because of the insufficiently high symmetry of the lattice. An expression, agreeing with experiment, is derived for the temp. dependence of the permittivity by differentiating the corrected Clausius–Mosotti equation. The linear variation of the Curie temp. of mixed crystals with composition is also accounted for. The coupling of Ti dipoles by easily polarized O ions explains the stability of the polarized state below the Curie point. A. L. MACKAY

537.226.08

250. Measurement of the dielectric constant and loss of solids and liquids by a cavity perturbation method. G. Birnbaum and J. Franeau. Letter in *J. Appl. Phys.*, **20**, 817–18 (*Aug.*, 1949).

The change in the resonant frequency and in the Q-factor of a rectangular cavity when a dielectric material is inserted in the cavity, is determined at 9 000 Mc/s by a method which presents the cavity resonance curve on an oscilloscope. The permittivity, κ, and power factor, $\tan\delta$, are derived from these

quantities, the estimated accuracy being $\pm 1\%$ for κ and $\pm 3\times10^{-4}$ for $\tan\delta$. E. RUSHTON

537.226.08

251. The measurement of dielectric constants of liquids by a frequency deviation method. W. L. G. GENT. *Trans. Faraday Soc.*, **45**, 758–9 (*Aug.* 1949).

The method, which allows a continuous check on the standard capacity by calibration against a crystal oscillator, is described. A.

537.226.2

252. Dielectric constant of silica. S. K. KULKARNI JATKAR AND B. R. YATHIRAJA IYENGAR. *Indian J. Phys.*, **23**, 145–52 (*April*, 1949).

The permittivities of crystal quartz and fused silica plates are 4·54 and 3·2 respectively as determined by the plate method. The mixture method gives the dielectric constant of powdered quartz as 4·55. The dipole moment of silica is calculated by a new equation. Considering SiO_2 moment as a vector of two mutually tetrahedrally inclined Si–O bonds the moment (observed) of Si–O bond is 0·86 *D*. The true moment of a free Si–O bond is $0\cdot86\times2$ (co-ordination number) $= 1\cdot72\,D$ agreeing with the calculated value. At low temps. ($\theta = 0$) the observed Si–O moment is 0·43 *D* so that the true moment of the free Si–O bond is again $1\cdot72\,D$ ($0\cdot43\times4$, the co-ordination number). A.

537.226.2

253. Ferro-electric properties of WO_3. B. T. MATTHIAS. Letter in *Phys. Rev.*, **76**, 430–1 (*Aug.* 1, 1949).

Tungstic oxide crystals grown from pure tungstic acid are triclinic and show a marked domain structure similar to that of ferro-electrics in the perovskite crystal system, except that the differences of lattice constants in different directions are about 5% as compared with 1% in the perovskite system. The crystals appear to be very soft, for the entire domain pattern can be shifted or changed without damage to the crystal when a small pressure is applied. At room temp. the electrical conductivity is very high, but at liquid air temps. the losses are small, and the permittivity is between 100 and 300. E. RUSHTON

537.226.2

254. Precision dielectric measurements on solutions of associating materials. Dipole moment and association. R. MECKE, A. REUTER AND R. L. SCHUPP. *Z. Naturforsch.*, **4a**, 182–91 (*June*, 1949) *In German.*

Permittivities of phenol/CCl_4 mixtures over the complete concentration range and 10–60°C are given. Interpretation using the Onsager theory leads to a heat of association of 4·3 kcal/mole and 0·68 *D* for the associated OH bond dipole moment.

D. H. WHIFFEN

537.226.2

255. The absolute dielectric constant of gases at pressures of 0–80 atm. at 25°C. J. CLAY AND F. VAN DER MAESEN. *Physica*, **15**, 467–80 (*July*, 1949) *In English.*

The measurements are based on a method of determining the absolute value of small differences of capacity by means of the cylindrical measuring condenser of Clay, a heterodyne beat-method being used. The principle of this method is given and also its application to calibrating the scale of a precision measuring condenser of 500 $\mu\mu$F, the latter being necessary to determine the active capacity of the condenser for gases. The dielectric constant of 4 gases (air, He, A and CO_2) has been determined at various pressures ranging from 0–80 atm. The function of Clausius–Mosotti has been calculated using results of isotherm-measurements given in the relevant literature. A.

537.226.2

256. The absolute dielectric constant of benzene. F. VAN DER MAESEN. *Physica*, **15**, 481–3 (*July*, 1949) *In English.*

Measurements were made for the determination of the absolute dielectric constant of benzene. Results were compared with earlier determinations. The method of purification is described. A.

537.226.2

257. Dielectric behaviour of methyl palmitate. W. JACKSON. Letter in *Nature, Lond.*, **164**, 486–7 (*Sept.* 17, 1949).

Methyl palmitate, previously reported on by Dryden and Jackson [Abstr. 3977 (1949)], has been investigated at about 20°C over a frequency range of 50 to 5×10^{10} c/s. The recrystallized sample now tested differs from the previous sample in that there is negligible power loss at low frequencies, and there is no dip in the permittivity curve at 3×10^9 c/s which had suggested the possibility of a resonance phenomenon. The existence of two separate absorption regions at 10^8 and 10^{10} c/s is confirmed.

E. RUSHTON

537.226.2 : 548.0

Dielectric constants of crystals. III. *See Abstr.* 584

537.228.1

258. Seignette-electrics. K. HAUSSER. *Z. angew. Phys.*, **1**, 289–94 (*Jan.*, 1949) *In German.*

This is a brief review, with bibliography, of the work done during the past 30 years on the origin of the piezo-electricity of the tartrates and phosphates, particularly Rochelle salt and KDP.

H. J. H. STARKS

537.228.1 : 621.396.611.21

259. Piezo-electric resonator of ethylene diamine tartrate with zero temperature coefficient of frequency. R. BECHMANN. Letter in *Nature, Lond.*, **164**, 190–1 (*July* 30, 1949).

There are two ways of cutting thin square plates of EDT so that they have a zero temp. coeff. of frequency when vibrating in the contour shear mode. One of these cuts is specially suitable for elements for crystal filters. Electrical and dynamic constants are given. H. J. H. STARKS

537.228.2 : 534.321.9

Ultrasonics and electrostriction. *See Abstr.* 100

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 530.162 : 621.385.2

260. Flicker effect in saturated diodes. L. DE QUEIROZ ORSINI. *C.R. Acad. Sci., Paris*, **228**, 1704–6 (*May* 30, 1949) *In French.*

The general formula of MacFarlane [*Proc. Phys.*

Soc., **59**, 366 (1947)] for the saturation current of a diode $I_f^2 = Gi^m/\omega^n$ where $m - n = 1$, has been verified in a first approximation. If, however, the saturation current is in the order of tens of mA, the formula is no longer valid. The derivation of MacFarlane's theory, that the spectrum distribution of the frequencies should be a plateau below 400 c/s, has not been verified. W. SUMMER

537.3 : 537.533 : 621.38

261. Some statistical properties of random noise. D. K. C. MACDONALD. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 3) 368–72 (1949).

An investigation into the distribution of change of phase, based on the joint distribution of phases and amplitudes obtained by Rice [*Bell Syst. Tech. J.*, **23**, 282 (1944); **24**, 46 (1945)]. N. L. JOHNSON

537.3 : 621.317.715

262. Sensitivity limit of galvanometers. M. SURDIN. *J. Phys. Radium*, **10**, 253–4 (*July–Aug.–Sept.*, 1949) *In French.*

Derives expressions for the effects of Brownian movement and thermal fluctuations and shows the result is independent of circuit resistance. [See *Elect. Engng, N.Y.*, **68**, 520 (*June*, 1949).

N. F. ASTBURY (R)

537.311

263. On the energy band structure of insulators. G. H. WANNIER. Letter in *Phys. Rev.*, **76**, 438–9 (*Aug.* 1, 1949).

In a semi-conductor of high impurity content, the position of the Fermi-level is either near the full band (*p*-type) or near the conduction band (*n*-type). For very small impurity contents it is often supposed that the Fermi-level is located at the centre of the forbidden band. It is shown that this is improbable and that the Fermi-level is more likely subject to spatial oscillations between its *n* and *p* positions. A model of this type may lead to an explanation of secondary photo-currents in insulators. H. K. HENISCH

537.311.3

264. Measurements on the negative temperature coefficient of nickel films. A. VAN ITTERBEEK, L. DE GREVE AND R. CELIS. *Physica*, **15**, 433–6 (*July* 1949) *In English.*

Thin films of Ni sputtered on to pyrex strips were found to have a negative temp.-coeff. of resistivity, dependent on the nature of the residual gas present and on the film thickness. The coeff. changes sign when the thickness reaches a critical value. The effect is thought to be due to cracks in the film. In order to pass these cracks, electrons would need a certain activation energy, and semi-conductor properties would thus be simulated. It must be expected that this activation energy would be influenced by the nature of adsorbed gases.

H. K. HENISCH

537.311.312.8

265. Thermal and electrical resistance of a tungsten single crystal at low temperatures and in high magnetic fields. J. DE NOBEL. *Physica*, **15**, 532–40 (*July* 1949) *In English.*

The thermal and electrical conductivities of the W single-crystal have been determined in high magnetic fields at low temps., in order to investigate whether the law of Wiedemann–Franz [*Physica*, **5**, 449 (1938)] holds for the electrical conductivity and the thermal conductivity, which is due to the electrons. The results show that this law is not valid in stronger fields. It is therefore not possible even in very high fields to separate the total conductivity into lattice and electronic thermal conductivity. A.

537.311.32 : 537.226 : 621.315.613.1

266. Electrical conductivity of mica in strong electric fields. B. V. GORELIK AND V. T. DMITRIEV. *J. Tech. Phys., USSR*, **18**, 333–40 (*March*, 1948) *In Russian.*

Measurements have been taken for field potentials of 5×10^4 to $3{\cdot}5 \times 10^6$ V/cm, at temps. of 89–235°C. Two ranges of conductivity are observed, the one conforming to the Poole formula and the other to the Frenkel theory, which explains sharp increase of conductivity with a lowering of the potential barrier for the electron. The relationship between van't Hoff constant and the field is determined.

ELECTRICAL RESEARCH ASSOCIATION

537.311.33

267. Some properties of the Ba_2SiO_4 oxide cathode interface. A. EISENSTEIN. *J. Appl. Phys.*, **20**, 776–90 (*Aug.*, 1949).

Oxide cathodes prepared on a Si–Ni alloy base metal have an interface of Ba orthosilicate. The thickness of this layer is measured by means of an X-ray method and found to increase with the life of the cathode and to be of the order of 10^{-3} cm. Measurements of the effective, specific electrical conductivity were made and compared with the conductivity of the coating (BaSr)O. Both materials exhibit a conductivity-temp. variation characteristic of semiconductors; however, the conductivity of the interface was always $<$ that of the coating. The interface layer influences the thermionic emission characteristics of the cathode due to an interface voltage developed by the flow of emission current. A retarding-potential method is developed for determining this voltage. A.

537.311.33

268. Conductivity and thermo-electric effect in cuprous oxide. N. N. GREENWOOD AND J. S. ANDERSON. *Nature, Lond.*, **164**, 346–7 (*Aug.* 27, 1949).

The thermo-electric power of cuprous oxide was found to be independent of temp. over the range in which the material displayed positive hole conduction. From conductivity measurements the activation energies at low and high temps. were determined as about 0·26 eV and 1 eV respectively. At temps. above 350°C the thermo-electric power decreases, probably due to the onset of intrinsic conduction, but does not change sign. Care was taken to use specimens in well-defined states of chemical equilibrium. It is concluded that the thermo-electric properties of impurity semiconductors whose composition is nearly stoichiometric are not adequately described by present theories. H. K. HENISCH

537.311.33

269. Neutron irradiated semiconductors. W. E. JOHNSON AND K. LARK-HOROVITZ. Letter in *Phys. Rev.*, **76**, 442–3 (*Aug.* 1, 1949).

After bombardment with deuterons and α-particles

semiconducting Ge is known to show permanent changes in electrical properties. Similar effects due to n-bombardment have recently been observed. The conductivity of *p*-type specimens increases under n-irradiation. That of *n*-type material decreases to a min. value and then increases again. Hall effect measurements show that it is gradually converted to *p*-type material. Thus n-bombardment produces electron acceptors. Some corresponding experiments on crystal rectifiers are also described.

H. K. HENISCH

537.311.33 : 538.632

270. Hall-effect of metal-semiconductor point contacts. S. BENZER. Letter in *Phys. Rev.*, **76**, 150 (*July* 1, 1949).

Measurement of the Hall effect in the neighbourhood of point contacts leads to useful qualitative information on the operating mechanism of crystal rectifiers and transistors. A Hall-e.m.f. can be observed between the point contacts of a transistor (if suitably oriented with respect to the magnetic field), if a current flows from one of the electrodes to the base. The unbalance voltage which exists before the application of the magnetic field must first be compensated. The sign of the Hall e.m.f. may be reversed if the current is increased beyond a certain limit.

H. K. HENISCH

537.311.33 : 621.314.632

271. The double-surface transistor. J. N. SHIVE. Letter in *Phys. Rev.*, **75**, 689–90 (*Feb.* 15, 1949).

A new form of crystal triode is described, using a small wedge of *n*-type high back-voltage Ge. Metal contacts bear on the opposite sides of the wedge, being separated by 0·01 cm, and a large area base contact is fitted. A small d.c. positive bias is applied to the emitter (for signal input) and a larger d.c. negative bias (−50 to −100 V) to the collector (load side). The static characteristics of the element and a theory of its action involving the concept of surface states are given. The element may be used for both voltage and current amplification.

C. A. HOGARTH

537.311.33 : 621.314.632

272. The relaxation effect of the cuprous oxide rectifier after the application of strong field. A. KOBAYASHI. *J. Phys. Soc. Japan*, **2**, 92 (*July–Aug.*, 1947) *In English.*

A brief account of negative current creep phenomena. The time-constant of the creep effect was found to be about 2 min, varying with temp. in accordance with $\exp(-Q/kT)$, where $Q = 0{\cdot}05$ eV.

H. K. HENISCH (R)

537.311.33 : 621.315.59 : 621.385.1.032.216

273. Semi-conducting properties in oxide cathodes. N. B. HANNAY, D. MACNAIR AND A. H. WHITE. *J. Appl. Phys.*, **20**, 669–81 (*July*, 1949).

It has been widely assumed, without adequate experimental verification, that (Ba, Sr)O, as used in the oxide cathode, is an excess electronic semiconductor. Accordingly, the electrical conductivity of (Ba, Sr)O has been studied as a function of temp. before and after activation with CH_4, extensive precautions being taken to exclude spurious effects. The increase in conductivity obtained characterizes (Ba, Sr)O as a "reduction" semi-conductor, and hence very probably as an electronic semi-conductor whose conduction electrons arise from a stoichiometric excess of (Ba, Sr) atoms in solid solution. A basic prediction of the semi-conductor theory has been tested quantitatively with the finding that the electrical conductivity is $\propto$ the thermionic emission of a (Ba, Sr)O cathode through 3 orders of magnitude of activation; well-defined chemical and electrical activation and deactivation procedures were used in obtaining this result. Activation may thus represent an increase in the chemical potential of the electrons in the oxide, little or no change in the state of the surface occurring. It has also been found that deviations from the proportionality of conductivity and emission may be expected under conditions leading to inhomogeneity in the oxide, in agreement with the semi-conductor theory also.

A.

537.311.4

274. The work function of copper. P. A. ANDERSON. *Phys. Rev.*, **76**, 388–90 (*Aug.* 1, 1949).

The work functions and ageing characteristics of 14 Cu surfaces have been determined by measurement of their contact differences of potential with respect to Ba reference surfaces of known work function. Measurement was by the retarding potential method in tubes sealed from the pumps and gettered with vaporized Ba. The Cu surfaces were prepared by subjecting Hilger's "spectroscopic standard" Cu to 40 vacuum fusions followed by fractional distillation, redistillation of the fractions and condensation of the vapour on glass. The Ba films were prepared by a similar, standardized technique which yields surfaces reproducible and constant to 0·01 eV or better. The time interval between the deposition and initial measurement of the metal films was of the order of 10 sec, obtained conveniently with a tube in which the target is returned to the measuring position automatically after deposition of a metal film upon it. The Cu surfaces, formed from successive fractions of the distillate, showed marked variability of the initial work function and marked drift toward lower work function in films 1–4, progressive improvement in films 5–8 and, finally, good reproducibility and negligible drift in films 9–14 inclusive. The range of variation in films 1–8 coincides almost exactly with the range of divergent values reported in the literature. Cu evidently retains dissolved gases, in free or combined form, with extraordinary tenacity, and these contaminants, evaporated with the Cu and reabsorbed by the condensing film, appear to be responsible for the variations observed in films 1–8. The work function value given by films 9–14 is $4{\cdot}46 \pm 0{\cdot}03$ eV, and this value is to be taken as representative of the present work.

A.

537.312.5

275. A new germanium photo-resistance cell. J. N. SHIVE. Letter in *Phys. Rev.*, **76**, 575 (*Aug.* 15, 1949).

In this cell the collector characteristics are modified by the photo-liberation of charge in the neighbouring semi-conductor. The area of the light spot is a few hundredths mm². The collector is biased negatively with respect to the peripheral contact through a resistor of up to 30 000 Ω. The frequency response is flat up to 200 kc/s. The spectral response extends

from about 5 600 Å to 1·7 and sometimes 1·9 μ. The max. centres around 1·5 μ. The overall quantum efficiency is 3 to 4 photoelectrons for each incident quantum at 1·5 μ. This inherent amplification is that generally observed in germanium transistors.

W. SUMMER

537.312.5

276. Conduction in photoconductive PbS films. H. M. JAMES. *Science*, **110**, 254–6 (*Sept.* 9, 1949).

Photosensitivity demands a careful balance between electron donor and acceptor impurity centres. Local variations in their concentration set up *p–n* barriers which are lowered by the incident radiation. It is shown that quite small fluctuations of impurity content give rise to large fluctuations of potential when the concentrations of excess and defect centres are nearly equal. In bulk specimens networks of *p* and *n* type material may simultaneously exist and carry most of the current. In thin films, the existence of highly conductive chains is unlikely, unless one type of impurity greatly predominates. Films of thickness 1 μ with high and nearly equal contents of donor and acceptor centres should give highest photoconductivity, particularly at low temps.

H. K. HENISCH

537.312.5 : 621.383.49

277. Infra-red conductivity in layers of tellurium and arsenic. T. S. Moss. Letter in *Proc. Phys. Soc., Lond. A*, **62**, 264–6 (*April*, 1949).

Thin layers of Te and As have been prepared by the evaporation method and both have been found to be photosensitive. The layers were of about 1 μ thickness; their response time is up to 1 msec. The specific resistance of the Te layer is 1 Ωcm at room temp. and that of arsenic is 10^6 Ωcm. At the temp. of liquid O the former increases this value by a factor of 10–20; the grey metallic As layer is changed to its red allotropic form and becomes insensitive. The max. sensitivity occurs for the Te at 1·4 μ, and for the As at 1 μ. At 2·7 μ and 1·7 μ, respectively, the sensitivities begin to fall off logarithmically.

W. SUMMER

537.312.62

278. Investigation of the attractive forces between the persistent currents in a superconductor and the lattice. E. U. CONDON AND E. MAXWELL. Letter in *Phys. Rev.*, **76**, 578 (*Aug.* 15, 1949).

The period of torsional oscillations of a superconducting Sn spheroid suspended by a torsion wire was studied as a function of a magnetic field applied horizontally. The observed variation could be attributed to slight secondary effects and it is concluded that the restoring torque due to the field is $< 1\%$ of what would be expected if the supercurrents were rigidly fixed to the spheroid. D. SHOENBERG

537.312.62

279. Magnetic moments and eddy current damping in spherical superconductors. J. J. FRITZ, O. D. GONZALES AND H. L. JOHNSTON. Letter in *Phys. Rev.*, **76**, 580–1 (*Aug.* 15, 1949).

Magnetic moments "frozen" into Sn spheres after various magnetic fields had been switched on and off were studied by timing torsional oscillations of the sphere suspended by a torsion wire in a small horizontal field. D. SHOENBERG

537.312.62

280. Some properties of superconductors below 1°K. I. Titanium. J. G. DAUNT AND C. V. HEER. *Phys. Rev.*, **76**, 715–17 (*Sept.* 15, 1949).

Magnetic measurements on Ti metal of purity 99·95% have been carried out down to 0·3°K. The Ti was found to be superconductive with a transition temp. of 0·53°K. Measurements of the magnetic threshold curve were made for which the initial slope was found to be 470 gauss per degree. A.

537.312.62 : 538.63

281. Fundamental considerations on the behaviour of a superconductor in a magnetic field. K. M. KOCH. *Öst. Ingen. Arch.*, **3** (*No.* 4) 344–56 (1949) *In German.*

The superconducting state is considered as a special case of an "ordered state" in the sense of the Bragg–Williams theory. The critical magnetic field is considered as due to an increase of ordering energy with field. It is claimed that the Meissner effect can be explained as arising from a tendency to the state of max. order. D. SHOENBERG

537.312.62 : 538.63

282. Magnetic effects of a rotating superconductor. W. F. LOVE, R. F. BLUNT AND P. B. ALERS. Letter in *Phys. Rev.*, **76**, 305 (*July* 15, 1949).

An appreciable fraction of the flux of the earth's horizontal magnetic field was "frozen" into a Sn spheroid (symmetry axis vertical) when it became superconducting. If the spheroid was spun at 5 000 r.p.m., however, no flux was frozen in.

D. SHOENBERG

537.312.62 : 538.63

283. The superconducting torus. R. L. DOLECEK AND J. DE LAUNAY. Letter in *Phys. Rev.*, **76**, 445–6 (*Aug.* 1, 1949).

The magnetic behaviour of a superconducting torus is discussed theoretically. D. SHOENBERG

537.312.62 : 539.164

284. The effect of alpha-particles on a superconductor. D. H. ANDREWS, R. D. FOWLER AND M. C. WILLIAMS. Letter in *Phys. Rev.*, **76**, 154–5 (*July* 1, 1949).

It was found that single α-particles could be detected by their transient heating effect on a superconducting bolometer. The counting efficiency was comparable with that of an ionization chamber. D. SHOENBERG

537.363

285. An apparatus for electrode reversal in the Tiselius electrophoresis equipment. H. TINT. *Rev. Sci. Instrum.*, **20**, 617–19 (*Aug.*, 1949).

ELECTRIC DISCHARGES 537.52

537.52 : 535.372

286. The influence of discharge parameters on the intensity of lines 1 850 and 2 537 Å in luminescent lamps. F. A. BUTAEVA AND V. A. FABRIKANT. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13** (*No.* 2) 271–4 (1949) *In Russian.*

Reference is made to previous papers [*Dokl. Akad. Nauk, SSSR*, **27**, 654 (1940): *J. Tech. Phys.*,

16, 1175 (1946)] dealing with the part played by the line 1 850 Å in the excitation of luminophores in fluorescent tubes. The absorption in air of that line influencing the accuracy of research, new measurements have been carried out with the use of a vacuum monochromator. The influence of (1) current intensity, (2) vapour pressure of Hg, and (3) presence of A, on the intensity of lines 1 850 and 2 537 Å, and the relative sensitivity of luminophores to the light of these two wavelengths have been examined. The relationship between current intensity and the intensity is linear in the case of the line 1 850 Å, and rather complicated in the case of the line 2 537 Å. Changes in vapour pressure produce maxima for both wavelengths. In the presence of A identical conditions are optimal for the generation of both resonance lines, and these conditions correspond to usual working conditions in fluorescent tubes. Light sensitivity to lines 1 850 and 2 537 Å of crystalline luminophores has been compared with that of such luminophores as machine oil, aesculin, rhodamine, uranium glass. [See also Abstr. 2521 (1949)]. F. LACHMAN

537.523.3 : 621.315.1.015.532

287. On the theory of the unipolar d.c. corona. V. I. Popkov. *Elektrichestvo* (*No.* 1) 33–48 (*Jan.*, 1949) *In Russian.*

The basic assumption of the theory is that the local field-strength differs in magnitude, but not in direction, from its value at the same position relative to similarly shaped electrodes between which no discharge is taking place. Ionic diffusion is shown to be negligible. The greater part of the treatment is valid for variable ionic mobility (k), though k is assumed constant in deriving some approximate general relationships. Experimental observations on the field-strength distribution between a wire (1·12 mm dia.) at 25 kV and a parallel earthed plane 25 cm away from it confirm the theory for constant k except very near the wire. The discrepancies are attributed to variation in k; such a variation would not occur in full-scale tests on transmission-lines, and hence the results of model-scale experiments should be applied in practice with this in mind. The dependence of corona-current upon inter-electrode voltage is calculated for a charged wire within a cylinder and for a charged wire near a parallel plane. Good agreement with experiment is obtained, except for thin negatively-charged wires. In the theory, the surface of the wire is assumed smooth, whereas in practice stranded wires with an uneven surface are often used. It is shown that the observed corona-current/voltage curve for a stranded wire can be fitted by overlapping segments of 3 different curves of the same form as that theoretically derived for a smooth wire.

A. SCHOFIELD (R)

537.523.4

288. The positive streamer mechanism of spark breakdown. W. Hopwood. *Proc. Phys. Soc., Lond. B*, **62**, 657–64 (*Oct.*, 1949).

The essential conditions for streamer onset in spark breakdown are discussed, with particular reference to the production of photo-ionizing radiation in the initial avalanche. It is shown that the process of electron-ion recombination can adequately account for the production of the necessary radiation, and is probably the predominant process. It is also shown that the yield of photons by this mechanism, and consequently the threshold for streamer advance, is critically dependent upon the space-charge field produced by the initial avalanche. While Meek's criterion in its quantitative form gives the order of this critical space-charge field and enables the breakdown voltage for uniform electric fields to be calculated, the newly proposed conditions for photon production give a new physical significance to the criterion. A.

537.523.4

289. An experimental investigation of the electrical and optical characteristics of spark breakdown in gases. E. Fünfer. *Z. angew. Phys.*, **1**, 295–304 (*March*, 1949) *In German.*

The behaviour of sparks along solid surfaces is discussed in detail, and particular attention is given to the obtaining of experimental data. Various forms of discharge gap assembly are described in which sparks in gases at about 1 atm. pressure are allowed to pass over surfaces. The emission of shock waves from the sparks is investigated with a Schlieren technique and the optical characteristics of the discharges are described in detail, using both spectroscopic and electron multiplier c.r.o. techniques.

J. D. CRAGGS

537.523.4 : 535.33.03

On the excitation temperature in spectroscopic spark source. *See Abstr.* 129

537.523.4 : 535.338

290. Spectrum of a torch discharge. K. N. Mochalov. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 2) 241–4 (1949) *In Russian.*

Torch discharges, at frequency $f \simeq 5 \times 10^7$ c/s, were investigated with a quartz spectrograph of working range 2 000–6 000 Å. The following spectra were examined: (1) discharge in O, (2) flame portion of discharge in air, (3) electrode spot, (4) discharge in CO with a small admixture of N. F. LACHMAN

537.523.4 : 621.317.35

291. The recording of optical transients. H. A. Prime and R. F. Saxe. *Proc. Instn Elect. Engrs, Pt II*, **96**, 662–9 (*Aug.*, 1949).

Four methods of recording the transient optical phenomena associated with the spark breakdown of gases are described. The duration of such transients may vary between the limits 10^{-3}–10^{-8} sec. The consequent problems, limitations and characteristics of the methods are discussed. The first two methods of recording are direct photographic techniques using the Kerr cell and the rotating-mirror camera respectively. The third method described is an indirect one, in which a photo-multiplier tube is used to convert the optical transient to an electrical one; the latter is then displayed on the screen of a high-speed oscillograph and photographed. This method makes use of a sealed-off c.r.t. which has a 9 cm screen and is operated from a 10 kV supply. The design of the oscillograph and the associated photo-multiplier and amplifier circuits are described and oscillograms illustrate the performance of the equipment. A recording technique is also considered, which is based on the application of television techniques to this

work. The principles of the method, which makes use of an iconoscope type of tube, are stated. A.

537.523.5

292. Heat losses in high-current arcs. K.-H. Höcker and P. Schulz. *Z. Naturforsch.*, **4a**, 266–70 (*July*, 1949) *In German.*

Heat energy from the column is lost by: diffusion of electrons and ions in all directions, heat conduction of the atoms (chemical conduction), and also heat conduction by the electrons. The 3 processes are discussed by the introduction of a *total* heat conduction coeff. composed of the atomic conduction coeff., the electron conduction coeff. and the coeff. representing losses due to ionization in the column and recombination at the boundaries. The electron conduction coeff. was determined from the motion of electrons and ions in the plasma, and the ion cross-sections were deduced and compared with values obtained by other workers. The calculated heat loss by electron conduction was about 30% of the radial heat loss from the column. F. LLEWELLYN JONES

537.525

293. On electron and photon avalanches, especially in the cylindrical field in hydrogen. G. Medicus. *Z. angew. Phys.*, **1**, 316–23 (*March*, 1949) *In German.*

Details are given of a method of calculating avalanche sizes in inhomogeneous electrostatic fields, and a similar treatment is then developed for the calculation of the number of excited atoms in an avalanche. The results are finally summarized, for H_2, in the form of graphs relating the discharge parameters to the ratio of electron and excited atom populations in the avalanche. J. D. CRAGGS

537.525 : 621.385.13

294. De-ionization of the positive column in a gas flow. I. Derivation of theory and technical application. J. Pachner. *Elektrotech. Obz.*, **37**, 385–92 (*Oct.* 20, 1948) *In Czech.*

Schottky's theory of low pressure gas discharge is briefly recapitulated, and the differential equation of the positive column derived in its most general form. This enables, even without integration of the equation, conclusions to be drawn, useful in the design of Hg-vapour valves. Only the velocity of the vapours needs to be calculated. The influence of the gas flow is the smaller, the lower the Hg-pressure and the higher the temp. of the anode cylinder.

B. F. KRAUS

537.525 : 621.385.13

295. De-ionization of the positive column in a gas flow. II. Check of the theory against measured results. J. Pachner. *Elektrotech. Obz.*, **37**, 392–7 (*Oct.* 20, 1948) *In Czech.*

The distribution of the concentration in the positive column is calculated for the static-stationary flow case for an infinitely long discharge tube. The space relation (co-ordinate : distance from anode) of the de-ionization then has an exponential character, as also has the time relation prior to the establishment of stationary conditions. The latter are achieved the sooner, the higher the gas velocity. The agreement with Deck's measurements is satisfactory and fairly good, within the limits of the experimental error. (Bibliography of 49 references.) B. F. KRAUS

537.525.5 : 535.33.03

Increase of the stability of the alternating-current arc in spark-type operation. *See Abstr.* 130

537.525.5 : 537.54

296. Electron-optical phenomena in the plasma of a low-pressure mercury arc. L. I. Golik and G. V. Spivak. *J. Tech. Phys., USSR*, **19**, 839–48 (*July*, 1949) *In Russian.*

Magnetic focusing of the plasma was investigated. The experiments were carried out in a side-arm of a discharge tube having an Hg cathode. A constriction at the cathode end of the side-arm produced a sudden potential change; the electron stream was given a directed velocity as it traversed the constriction and a short distance beyond it passed into the field of one or two magnetic lenses. The influence upon focusing of such factors as the current flowing, the magnetic field strength, the location of the lenses and the degree of constriction was examined. The field strength for optimum focusing decreases as the current increases; for given current and field strength improved focusing is obtained with a narrower constriction. By using two lenses a concentrated beam a few mm dia. and approx. 10 cm long was obtained. A. SCHOFIELD

537.525.5 : 621.314.65

297. On the vapour density changes in mercury arc rectifiers at the instant of backfiring. A. Lutz and R. Coumes. *C.R. Acad. Sci., Paris*, **228**, 552–3 (*Feb.* 14, 1949) *In French.*

The vapour pressure in certain Hg vapour rectifiers, measured with ionization gauges, was (1) measured as a mean quantity throughout the cycle of operation, and (2) displayed oscillographically. The ionization gauges could be placed in different parts of the discharge plasma, and the results obtained for certain test positions are briefly described. J. D. CRAGGS

537.525.6

298. Electron-optical effects during the development of the plasma. G. V. Spivak and E. L. Stolyarova. *J. Tech. Phys., USSR*, **18**, 279–88 (*March*, 1948) *In Russian.*

Experiments on the effect of a magnetic lens on the ignition potential in a long discharge tube.

B. F. KRAUS

537.525.8

299. Disturbance of thermodynamic equilibrium in the plasma, caused by the emission of radiation. L. M. Biberman. *J. Exp. Theor. Phys., USSR*, **19**, 584–90 (*July*, 1949) *In Russian.*

The disturbance of plasma equilibrium caused by the emission of radiation has been examined. Distribution of excited atoms with respect to co-ordinates has been obtained, for the case of small deviations from the state of equilibrium. The decrease of concentration of excited atoms towards the boundary of the source—even assuming constancy of temp.—results in the self-inversion of the radiation line if the source has finite dimensions, and in the appearance of absorption lines if the source occupies the semi-space. F. LACHMAN

537.529 : 548.0

Breakdown of ionic crystals by electron avalanches. *See Abstr.* 585

X-RAYS 537.531

537.531 : 535.3

300. A Geiger counter spectrometer for the measurement of Debye–Scherrer line shapes. W. H. HALL, U. W. ARNDT AND R. A. SMITH. *Proc. Phys. Soc., Lond. A*, **62**, 631–8 (*Oct.*, 1949).

A spectrometer for the accurate measurement of X-ray powder diffraction line intensities and shapes is described. Monochromatic radiation is used, and the diffracted beam intensity is recorded by a Geiger counter. The intensity of the X-ray source is monitored continuously, and errors due to variations in its output are automatically compensated. The accuracy and resolution obtainable are demonstrated by some typical experimental results. A.

537.531 : 535.34

301. Penetration and diffusion of hard X-rays through thick barriers. I. The approach to spectral equilibrium. H. A. BETHE, U. FANO AND P. R. KARR. *Phys. Rev.*, **76**, 538–40 (*Aug.* 15, 1949).

When some of the secondary components of a complex radiation are barely softer than the primary, the process of formation and decay of these components alone governs the approach to equilibrium. It is then possible to determine the asymptotic trend of the total radiation intensity at great depths of penetration. Under broad assumptions, this trend is $x^{K_0} \exp(-\mu_0 x)$. A.

537.531 : 615.849

302. Physical characteristics of soft roentgen rays. E. D. TROUT AND R. M. GAGER. *Amer. J. Roentgenol. Radium Ther.*, **62**, 91–112 (*July*, 1949).

An investigation of the physical characteristics of the radiation from an X-ray tube with a 2 mm Be-to-air window operated at 10 to 100 kV. Measurements made with a 250 *r* nylon Victoreen ion chamber and a standard air chamber showed a failure of the inverse square law and a change in quality, at short distances, due to air absorption. Transmission curves in Be, Al and polyethylene, backscatter data and depth dose information for radiation quality of H.V.L. 0·06 to 3·1 mm Al indicate clinical possibilities for the very soft radiation. T. A. CHALMERS

537.531.85 : 539.166.831

Electrons ejected by polarised radiation. *See Abstr.* 474

537.531.9 : 539.172.3

Recent nuclear experiments with high voltage X-rays. *See Abstr.* 502

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533/.534

303. Absolute speed gauge for high voltage particles. W. ALTAR and M. GARBUNY. *Phys. Rev.*, **76**, 496–501 (*Aug.* 15, 1949).

A precision method has been devised to measure nuclear reaction voltages, and equipment has been built capable of measuring reaction energies of charged heavy particles in the MeV range with accuracies of $\sim 0{\cdot}1\%$. Limitations of the operation are discussed and the possibility of a direct determination of e/m and related fundamental constants is pointed out. To verify the conclusions reached, test runs have been carried out with electron beams, and performance was as expected. A.

537.533

304. Betatron injection into synchrotrons. F. K. GOWARD. *Proc. Phys. Soc., Lond. A*, **62**, 617–31 (*Oct.*, 1949).

Gives the factors influencing the proportion of electrons which may be trapped and accelerated in a transition from betatron to synchrotron operation; this transition is a vital factor influencing the design of the normal electron-synchrotron. Machines of various energies are studied, and it is shown that the important considerations in the design are quite different in different energy ranges. The theoretical predictions are compared with experimental evidence obtained on 14 and 70 MeV synchrotrons, and the agreement is sufficient to give confidence in the simplified theory. A.

537.533 : 621.385.833

305. Control of a beam of electrons by an intersecting electron beam. J. L. H. JONKER AND A. J. W. M. VAN OVERBEEK. Letter in *Nature, Lond.*, **164**, 276–7 (*Aug.* 13, 1949).

A control electron beam intersects the working beam at right angles. The intersection takes place in a closed space whose walls are shaped so that the point of intersection is a convex saddle point. The control beam depresses the potential of the saddle point in proportion to the current. The saddle point potential in turn controls the proportion of the current in the main beam which can reach the anode. An experimental tube gave a max. slope of 23 mA/volt/mA, i.e. nearly twice the theoretical max. of grid control valves. The final anode current was about 6 μA for this slope. The use of secondary emission multiplication to increase the slope and current is mentioned. A. H. W. BECK

537.533 : 778.3

306. Studies of photoelectrons in photographic plates. J. BLUM. *C.R. Acad. Sci., Paris*, **228**, 918–20 (*March* 14, 1949) *In French.*

Electron sensitive nuclear track emulsions (Kodak NT2a) were exposed in an X-ray spectrograph and the range-energy relationship for electrons released by Ag $K_{\alpha_1-\alpha_2}$ and Ag K_β radiation has been established. The energies of the electrons measured are below 25 kV and agree well with the range-energy curves for electrons given by Ross and Zajac, and Herz. Some very short and densely ionized electron tracks and a few small stars with 2 and 3 branches have been observed. The former have been attributed to Auger electrons and the latter to electrons originating from atoms within the same grain.

R. H. HERZ

537.533.7 : 621.385.1.029.6

307. Space-charge wave amplification effects. V. A. BAILEY. *Phys. Rev.*, **75**, 1104–5 (*April* 1, 1949).

Haeff's method of amplifying microwave energy [Abstr. 4823 (1949)] is compared with two other mechanisms of wave-amplification, described by Pierce [Abstr. 2133 (1948)] and Bailey [Abstr. 2846 (1948)]. P. M. DAVIDSON

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537.533.72 : 621.385.833

308. A magnetic beam-splitting focusing device for the electron microscope. F. W. BISHOP. *Rev. Sci. Instrum.*, **20**, 532–3 (*July*, 1949).

The incident beam in an electron microscope is caused to pass through the specimen at a slightly different angle from normal by an electromagnetic coil. A similar coil mounted on the opposite side of the microscope is capable of causing a deflection in the opposite sense; and by application of a square wave it is arranged that the two alternate. If the instrument is not correctly focused, two images of the specimen are seen. These coincide when exact focus is achieved. J. THEWLIS

537.533.72 : 621.385.833

309. Electron diffraction experiments in an electron microscope. H. MAHL. *Phys. Bl.*, **5** (*No.* 2) 76–8 (1949) *In German.*

The steps necessary to convert an electron microscope into an electron diffraction apparatus are enumerated. A. H. W. BECK

537.533.72 : 621.385.833

310. The electrostatic lens as a high resolving power velocity analyser. G. MÖLLENSTEDT AND F. HEISE. *Phys. Bl.*, **5** (*No.* 2) 80–4 (1949) *In German.*

It is shown that the symmetrical electrostatic lens can be used as a velocity analyser which can detect velocity variations of < 1 in 10^4. A. H. W. BECK

537.533.72 : 621.385.833

311. On paraxial electron-optical image formation. F. BORGNIS. *Helv. Phys. Acta*, **22** (*No.* 3) 261–4 (1949) *In German.*

The results of an earlier paper [*ibid.*, **21**, 461 (1948)] are extended. It is shown that if the paths of two rays through the system are given, the potential and magnetic field at all points can be derived. Further references to the literature are given. A. H. W. BECK

537.533.72 : 621.385.833

312. On the calculation of the axial potential and its derivatives in an axially symmetrical immersion objective. M. DUCHESNE. *C.R. Acad. Sci., Paris*, **228**, 1407–8 (*May* 2, 1949) *In French.*

In the case considered (an image converter with 2 aperture electrodes successively in front of the cathode) the solution of Laplace's eqn., with suitable choice of origin, reduces to:

$$V(r,z) = \int_0^\infty A_k \sin kz \,.\, J_0(ikr)dk$$

where J_0 is the zero order Bessel function. A_k is evaluated by assuming the potential to vary linearly between the electrodes at $r = R$, the radius of the apertures. At each required value of z, the axial distance from the cathode, the axial potential is obtained by graphical integration with respect to k, the integrand converging rapidly to zero for $k > \pi$. Tests with a practical example gave agreement with electrolytic tank measurements, within the limits of experimental error. By successive differentiation under the sign of integration, the axial derivatives of the axial potential, needed for electron optical computations, are obtained with far greater accuracy than by numerical differentiation of electrolytic tank data. J. C. E. JENNINGS

537.533.72 : 621.385.833

313. Use of marginal rays for the study of asymmetry in electrostatic lenses. F. BERTEIN AND E. REGENSTREIF. *C.R. Acad. Sci., Paris*, **228**, 1854–6 (*June* 13, 1949) *In French.*

537.533.72 : 621.385.833

314. Field asymmetry in electrostatic lenses due to the high tension lead. F. BERTEIN. *C.R. Acad. Sci., Paris*, **229**, 291–3 (*July* 25, 1949) *In French.*

A calculation is made, neglecting the effect of the axial apertures and the part of the connection inside the lens. Perceptible effects can be produced for practical values of beam aperture. A. H. W. BECK

537.533.73 : 621.317.32

315. Diffraction of electron beams with velocity spread and application to the measurement of high a.c. voltages. J. J. TRILLAT. *C.R. Acad. Sci., Paris*, **223**, 322–4 (*Aug.* 12, 1946) *In French.*

The high voltage is used to accelerate a beam of electrons towards a mica sheet. The diffraction pattern consists in this case of radial "comets." Formulae for the dimensions of these traces in terms of the voltage are given. A. H. W. BECK (R)

537.533.73 : 621.385.833

316. Operational features of a new electron diffraction unit. R. G. PICARD, P. C. SMITH and J. H. REISNER. *Rev. Sci. Instrum.*, **20**, 601–11 (*Aug.*, 1949).

A new electron diffraction unit having a 3-lens optical system and a maximum effective specimen-to-plate distance of 200 cm is described. The applications of such a system to the study of long interatomic spacings is discussed. Wide variations in the area of specimen irradiated are obtainable. The use of the unit as a shadow microscope is explained, and the advantages are given of this instrument over other shadow microscopes with respect to increased size of image, increased size of specimen field available for observation, and greater specimen protection from damage by the concentrated electron beam. The resolution attainable with the instrument is calculated and a "resolution index" is defined which makes possible intercomparisons of resolution under various operating conditions. Factors which limit accuracy, as opposed to resolution, are discussed critically and the accuracy of data obtainable with the instrument is estimated. A number of diffraction patterns is shown to illustrate the results obtained under various operating conditions as diffraction camera and shadow microscope, and also to illustrate the techniques of charge neutralization, spot diameter measurement, and internal calibration of plates using a known specimen. A.

537.533.74

317. The elastic scattering of electrons by neutral hydrogen atoms by the variational method. S.-S. HUANG. *Phys. Rev.*, **76**, 477–81 (*Aug.* 15, 1949).

Two variational methods are proposed for computing the phase shifts for an electron scattered by a neutral atom. These methods are shown to be different formulations of the same physical principle, i.e. the stationary property of the phase shift. By applying one of these methods to the S scattering of an electron by a hydrogen atom, the phase shifts are computed for various kinetic energies. A com-

parison is finally made with the results which Morse and Allis [*ibid.*, **44**, 269 (1933)] have derived from the solution of the Fock equation. A.

537.533.75

318. The penetration of high energy electrons in aluminium. F. L. Hereford and C. P. Swann. Letter in *Phys. Rev.*, **76**, 570–1 (*Aug.* 15, 1949).

The β spectrum of B^{12}, prepared through the reaction $B^{11}(d,p)B^{12}$ (β end-point 13·4 MeV) was used as a source of high energy electrons. Monokinetic beams were obtained through a magnetic analyser of $\sim 4\%$ resolution and a range of 3–12 MeV was covered. The practical maximum range in Al (obtained by extrapolating the linear portion of the absorption curve) was obtained as a function of energy. Above 5 MeV the experimentally observed ranges were lower than those calculated by Fowler, Lauritsen and Lauritsen. The end point for the absorption of B^{12} β-particles was also measured by the Feather method. L. R. SHEPHERD

537.533.79 : 621.396.61

319. Čerenkov radiation. F. X. Eder. *Funk u. Ton*, **3**, 67–73 (*Feb.*, 1949) *In German.*

A critical review of the work so far published by American and Russian authors on the asymmetrical radiation associated with an electron which traverses a solid or liquid medium with a velocity > that of light in the medium. It is suggested that the recent theoretical work of Ginsburg and Frank may be realized by employing pulses derived from an oscillating klystron. By this means a new source of mm-waves might be available. S. C. DUNN (R)

537.534 : 621.384.6

320. Arrangement for automatic synchronization in a cyclotron. P. Debraine and C. Siméně. *J. Phys. Radium* (*Sér.* 8) **9**, 113–21 (*April*, 1948) *In French.*

A fuller account of the system for synchronization of Abstr. 2514 B (1948) [*Ann. Télécommun.*, **3**, 57–71 (*Feb.*); 85–104 (*March*, 1948)]. The magnetic field of a cyclotron is made to vary periodically with very small amplitude and the resulting variations in beam current are amplified. If these are symmetrical about the value corresponding to the mean value of magnetic field this field must be at the optimum running value. If they are unsymmetrical the phase of closing of a relay is controlled to alter the magnet current in the correct direction. Complete details of the circuit used for the cyclotron at the Collège de France are given. J. H. FREMLIN (R)

537.534 : 778.3

Fading of proton tracks in vacuum. *See Abstr.* 643

537.534.74

321. A note on the stopping of fast charged particles in metallic conductors. R. Kronig. *Physica*, **15**, 667–70 (*Aug.* 1949) *In English.*

The relationship of the theories of Kronig and Korringa [Abstr. 1891 (1946)] and of Kramers [Abstr. 3301 (1947)] for the stopping of fast charged particles in metals is elucidated. A.

537.534.74 : 539.152.1

322. Double scattering of protons in helium. D. C. Dodder. Letter in *Phys. Rev.*, **76**, 683 (*Sept.* 1, 1949).

The intensity of double scattering has been calculated in the form $M + N \cos \phi$ where ϕ is the azimuthal angle about the secondary beam measured from the direction of the primary. Numerical estimates suggest that it should be possible to use this method to remove the ambiguity in the p-wave phase shifts of single scattering, corresponding to normal and inverted double in Li^5 [Abstr. 2553 (1949)]. G. J. KYNCH

537.534.75

323. Proton stopping power of gold. T. Huus and C. B. Madsen. Letter in *Phys. Rev.*, **76**, 323 (*July* 15, 1949).

The proton stopping power of Au foils ($\sim \frac{1}{2}$ mg/cm^2) has been measured by observing the proton beam energies required to produce the F-339 and Al-986 resonances, with the Au foils inserted in the beam. Typical results indicated a stopping power of 85 mgm/cm^2 for protons with a mean energy of 364 keV and 60 mgm/cm^2 for protons with mean energy 1 003 keV. L. R. SHEPHERD

DISCHARGE TUBES . COUNTERS 537.54

537.542

324. Ion source for mass spectrography. R. F. K. Herzog and F. P. Viehböck. Letter in *Phys. Rev.*, **76**, 855–6 (*Sept.* 15, 1949).

Neutral molecules, sputtered from the cathode of a discharge tube, may be ionized on the axis of the tube; this method, often used in mass spectrography, has been improved by the addition of an accelerating electric field near a solid sample which is bombarded by ions from a discharge tube. There is differential pumping between the accelerating chamber and the discharge tube, and the ion beam is mono-energetic and fairly well focussed. T. G. PICKAVANCE

537.542

325. A high current ion source. R. B. Setlow. *Rev. Sci. Instrum.*, **20**, 558–60 (*Aug.*, 1949).

An ion source is described which utilizes a hot cathode as an electron source and an axial magnetic field for focusing. The electron beam is pulsed for 250 μsec 60 times a sec. Peak ion currents of 100 mA are readily obtainable. At a H pressure of 25 microns of Hg the proton content of the beam is between 30 and 40%. Constructional details and operating conditions are given. A.

537.542

326. Electron mobilities in Geiger–Müller counters. H. den Hartog, F. A. Muller and C. S. W. van Rooden. *Physica*, **15**, 581–7 (*July*, 1949) *In English.*

A description of further measurements of electron mobilities in a self-quenching Geiger–Müller counter containing various mixtures of A and alcohol. The electron mobility in a mixture of 90 mm A and 10 mm alcohol vapour is found to be 15 700 ± 5%, the mobility in 100 mm alcohol vapour (extrapolated), 1 640 ± 5% cm/sec per volt/cm. For the range of alcohol pressures covered, viz. 1·5 to 27 mm (100 mm total pressure) the cross-section of A is negligible except at the very lowest pressures. A.

537.542

327. A type of counter permitting absolute measurement of disintegration rate in a β active source. R. COHEN. *C.R. Acad. Sci., Paris*, **229**, 356–8 (*Aug.* 1, 1949) *In French.*

A solid angle of 4π is obtained by mounting the source, internally on a thin foil between two parallel wire anodes of the counter. The efficiency for counting UX_2 β-particles was found to reach 100%, with a filling of 10 mm of alcohol and >50 mm A. A plateau of 200 V with slope 1% per 100 V was observed to be reproducible over several months. The counter has been used in a circuit with a 10^{-3} sec paralysis time T and the formula $N_{\text{counted}} = N_{\text{true}}/(1 + N_{\text{true}}\,T)$ has been checked for counting rates up to 150 000 per min. An overall accuracy of better than 3% is claimed. L. R. SHEPHERD

537.542

328. Investigation of soft radiation by proportional counters. V. Use as a detector of ultra-violet quanta and analysis of the gas multiplication process. S. C. CURRAN, A. L. COCKCROFT and J. ANGUS. *Phil. Mag.*, **40**, 929–37 (*Sept.*, 1949).

Quantitative detection of single slow electrons liberated by light at the cathode of a proportional counter was observed and good plateaux were obtained. The amplitude distribution of the output pulses was measured; the shape of the distribution corresponds closely with the curve $x^{\frac{1}{2}} \exp(-x)$. The variation introduced by the gas gain alone was calculated for various fixed amounts of ionization and compared with the experimental observations on homogeneous radiations. By this means the fluctuations in the number of ion pairs released in the gas by electrons totally absorbed in the counter were deduced. The total variation can be split into 2 main components, of about equal magnitude and < predicted by current theory. L. S. GODDARD

537.542 : 539.164

329. Note on the measurements of α-particle energies with scintillation counters. B. ALER AND T. WIEDLING. *Ark. Fys.*, **1**, *Paper* 16, 335–8 (1949) *In English.*

Experiments on the detection of Po α-particles using R.C.A. photo-multiplier tubes to measure scintillations in naphthalene crystals or pieces of Philips Metalix fluorescent screens, are described. Detailed studies of pulse size distributions were made and are summarized graphically. J. D. CRAGGS

537.542 : 537.531.8

330. Detection of X-ray quanta by a cadmium sulphide crystal counter. S. G. ZIZZO AND J. B. PLATT. Letter in *Phys. Rev.*, **76**, 704–5 (*Sept.* 1, 1949).

A fairly detailed description is given of the use of a CdS crystal (7×10^{-3} cm thick, with 21 V applied between graphite surfaces coated on opposite sides of it) for the measurement of X-rays (0·35–0·6 Å). Pulse sizes ~ 20–30 μV were used. The circuit of the pre-amplifier is shown. About 14 eV, or perhaps less, are required for the production of one conduction electron. J. D. CRAGGS

537.542

331. The scintillation counter. I. The existence of plateaus. L. B. ROBINSON AND J. R. ARNOLD. *Rev. Sci. Instrum.*, **20**, 549–53 (*Aug.*, 1949).

A method has been developed whereby inorganic phosphors can be mounted on a photo-multiplier tube in thin films. The ZnS : Ag phosphor is quite satisfactory for use in conjunction with the 931A phototube. Plateaux have been established similar to those associated with G.–M. counter tubes and the associated circuits. A.

537.542

332. A scintillation counter for laboratory counting of alpha-particles. J. D. GRAVES AND J. P. DYSON. *Rev. Sci. Instrum.*, **20**, 560–5 (*Aug.*, 1949).

A simple, reliable, wide range α-counter has been developed which is suitable for the routine counting accompanying radiochemical laboratory analysis. This instrument utilizes the α-scintillation process in conjunction with a photomultiplier tube and a commercial Geiger tube power supply, amplifier and scaler. Desirable features include low cost, ease of construction, ruggedness and long life. Tests performed on the completed counter assembly indicated the following operating characteristics: a counting efficiency of 100% for 4–5 MeV α-particles; a resolving time limited by the electronic circuits (photomultiplier pulses have a rise time of about 0·5 μsec); a counting rate unaffected by variations in temp., humidity or pressure; a background < 10 counts/hr. The chief undesirable feature is the small field of view for high sensitivity. Samples to be counted must be small, about $\frac{1}{4} \times \frac{1}{4}$ in maximum, and must be confined to a known region on the sample holder. A.

537.542 : 578

333. Measurement of ionizing radiations *in vivo*. B. CASSEN AND L. CURTIS. *Science*, **110**, 94–5 (*July* 22, 1949).

A fluorescent crystal inserted in the end of a Lucite rod, coupled with a photocell and amplifier, provides a radiation measuring instrument of high sensitivity and resolution. An a.c. amplifier may be used either for direct counting of α-particles or for measurement of average X-ray intensity in a medium from a self-rectifying tube. The instrument is suitable for detailed iso-dose curve measurements. F. T. FARMER

537.542

334. The Rosenblum spark counter: a new counter for the detection of fast ionizing particles. R. M. PAYNE. *J. Sci. Instrum. Phys. Ind.*, **26**, 321–4 (*Oct.*, 1949).

An investigation has been made of the characteristics of the α-particle wire counter demonstrated by Rosenblum [Abstr. 1942 (1945)], and to examine the possibility of using it for the detection of less ionizing particles. A particle is recorded by the passage of a spark between a fine wire and a flat plate in close proximity, and between which a corona discharge exists in the open air. Counters of this type can be constructed with a plateau of about 2 500 V in length by using higher voltages than those originally suggested by Rosenblum. The accidental rate is < one in 4 hr and the dead time is about 10^{-4} sec. The recording properties of the counter are shown to depend on the direction of the incident particles in passing through the sheath of corona discharge surrounding the wire. By using a wire-plate system, some objections to the earlier point-plate counter of Greinacher [*Helv. Phys. Acta*, **9**, 590 (1936)] are eliminated. The result is an instrument

of great simplicity and which might have important advantages for many purposes. When the counter is working in an atmosphere of CO_2 or a 1% mixture of this gas with air, it is also capable of detecting protons and fast electrons. Such a development will greatly increase its field of application. A.

537.542

335. An instrument for measuring curvature of cloud-chamber tracks. E. R. GAERTTNER AND M. L. YEATER. *Rev. Sci. Instrum.*, **20**, 526–7 (*July*, 1949).

The instrument provides for positive setting and direct reading of the elements for a 3-point determination of cloud-chamber track curvature. The base of the instrument is locked when a first point is fixed, and an upper section is rotated until an appropriate track segment up to second point is fixed. The lateral displacement of the centre of the selected segment is then read directly on a micrometer head.

J. G. WILSON

537.542

336. A fast recycling cloud chamber and pulsed magnetic field equipment for use with pulsed accelerators. E. R. GAERTTNER AND M. L. YEATER. *Rev. Sci. Instrum.*, **20**, 588–96 (*Aug.*, 1949).

The chamber is operated at a repetition period of about 5 sec. An "overcompression" step in the cloud-chamber cycle causes old tracks to be evaporated by momentary heating of the gas through compression. A pulsed magnetic field of 12 msec duration is used. The field is produced by discharging capacitors through Helmholtz coils. With these short current pulses, strong fields (20 000 gauss or more) are obtainable at fast cloud-chamber recycling rates with relatively small heating of the coils. A.

537.542

337. A simple counter tube amplifier. H. GOLDSTEIN. *Z. angew. Phys.*, **1**, 329–30 (*March*, 1949) *In German.*

Simple 2 and 3 hard-valve circuits for amplifying and counting Geiger counter impulses are briefly described. The circuits, given in detail, are suitable for use with 2 and 50 MΩ counter tube resistances for the 2 and 3 valve circuits respectively.

J. D. CRAGGS

537.542

338. Counting with Geiger counters. H. E. NEWELL, JR. AND E. C. PRESSLY. *Rev. Sci. Instrum.*, **20**, 568–72 (*Aug.*, 1949).

The coincidence rate of a perfectly efficient 2-counter telescope is obtained in terms of the radiation intensity and the effective dimensions and separation of the counters comprising the telescope. Formulae are presented for the counting rate in a field of isotropic radiation and in a field where radiation varies with the zenith angle in accordance with a $\cos^2$ law. By means of the formulae the counting rate may be located between an upper and a lower bound which in most practical cases differ by only a few %. The information embodied in the formulae is also presented graphically in a form convenient for ready calculation of the ratio of coincidence rate to radiation intensity once the effective dimensions and separation of the counters are known. A.

537.542 : 519.2

339. The theory of counting experiments using pulsed sources: chance coincidences and counting-rate losses. N. FEATHER. *Proc. Camb. Phil. Soc.*, **45** (*Pt* 4) 648–59 (1949).

The mean rate of chance coincidences with a periodic source is obtained. The cases of (*a*) complete modulation (sinusoidal waveform) and (*b*) sharp pulses (square waveform) are considered in some detail. Counting-rate losses are discussed in detail for case (*b*). N. L. JOHNSON

IONIZATION . THERMIONICS 537.56/.58

537.562

340. Townsend's ionization coefficient for helium. S. H. DUNLOP. Letter in *Nature, Lond.*, **164**, 452 (*Sept.* 10, 1949).

The coeff. α is calculated over a range of X/p from 3 to 10 V/cm/mm Hg, using values of electron drift velocity and energy distributing function calculated by Smit (1936); extrapolated values of α are lower than those measured by Townsend and McCallum for $X/p > 12$. F. LLEWELLYN JONES

537.581

341. Thermionic electron emission from carbon. H. F. IVEY. Letter in *Phys. Rev.*, **76**, 567 (*Aug.* 15, 1949).

The thermionic constants for C are given from measurements at 1 610, 2 125 and 2 335°K, after outgassing at up to 2 525°K. For the 2 higher temps. the value of ϕ (4·60 eV) lies between the highest recorded value (Bhatnagar, 4·84 eV) and those of other workers (4·3–4·4 eV). The value of A (46 A/cm²/deg²) agrees with the previous max. value. The emission current densities at 1 500°K and 2 000°K are compared with previous results and shown to be < those hitherto recorded, possibly due to the severe heat treatment used. T. EMMERSON

537.581 : 621.385.2

342. Cathode field in diodes under partial space-charge conditions. H. F. IVEY. *Phys. Rev.*, **76**, 554–8 (*Aug.* 15, 1949).

A method for calculating the electric field at the cathode of a diode for any condition of current flow in the diode is presented. A "universal" curve gives the cathode field as a function of diode current. The equation for this curve is

$$\frac{I}{I_s} = \frac{1}{2}\left[1 \pm \left\{1 - \frac{27}{4}\left(\frac{E}{E_0}\right)^2\left(1 - \frac{E}{E_0}\right)\right\}^{\frac{1}{2}}\right]$$

where I is the diode current, I_s is the saturation current corresponding to the applied anode voltage as calculated from the Child–Langmuir equation, E is the cathode field, and E_0 is the value of E in the absence of current flow. The only restrictions on the derivation are those of an equipotential, smooth cathode and negligible initial velocities of emission. Only plane and cylindrical diodes have been considered, but the results are believed to be applicable to any geometry. Application of the results to the

study of thermionic cathodes in the Schottky emission region is very straightforward. The variation of the cathode field as a function of anode voltage is also discussed. A method for calculating the potential distribution in a plane diode for any value of diode current is given in an appendix. A.

537.583 : 621.385.1.032.216

343. On the evaporation of oxide cathode. H. KAWAMURA. *J. Phys. Soc. Japan*, **1**, 8–11 (*July–Dec.*, 1946) *In English.*

The rate of evaporation was measured by allowing the evaporated material to activate a W wire. The rate of evaporation was found to be independent of the thermionic current drawn but to depend on the secondary structure of the crystal and the core material. If the rate of evaporation is written in the form $M = A \exp(-Ee/kT)$ the values obtained were $A = 3{\cdot}3\times10^4$, $E = 2{\cdot}9$ eV for equimolecular Ba(Sr)O and $A = 2{\cdot}7\times10^6$, $E = 3{\cdot}9$ eV for BaO. It is concluded that molecular BaO is evaporated from the cathode. The fact that the activation energies obtained are $\ll$ than those quoted in the literature is held to be due to a different degree of sintering. A. H. W. BECK (R)

COSMIC RAYS 537.591

537.591

344. The specific ionization of the cosmic radiation above the atmosphere. S. F. SINGER. Letter in *Phys. Rev.*, **76**, 701–2 (*Sept.* 1, 1949).

A fourfold counter telescope, including one low efficiency counter (5 cm H_2), was operated under 1 g/cm² Al in a rocket. The corrected measured efficiency of the low efficiency counter was significantly higher than at sea level, and it is concluded that either the primary radiation contains a proportion of multicharged particles (e.g. 20% α-particles) or else that a significant secondary component, perhaps backscattered from the atmosphere, is involved. J. G. WILSON

537.591

345. On positive excess of meson component near sea level. P. BASSI, E. CLEMENTEL, I. FILOSOFO AND G. PUPPI. Letter in *Phys. Rev.*, **76**, 854 (*Sept.* 15, 1949).

A magnetic deflection system which focuses particles of momentum $2{\cdot}2\times10^8$ eV/cm is used in conjunction with degrading absorbers to investigate the positive excess of sea-level mesons up to a momentum of about 2×10^9 eV/cm. It is concluded that up to this momentum there is no reduction of the excess with increasing momentum. J. G. WILSON

537.591 : 539.18

346. The meson intensity at the surface of the earth and the temperature at the production level. A. DUPERIER. *Proc. Phys. Soc., Lond. A*, **62**, 684–96 (*Nov.*, 1949).

Meson intensity has been recorded by using a triple-coincidence arrangement with a Pb absorber 25 cm thick between the counters. The comparison of daily mean values with the height of a number of pressure-levels has made it necessary to take into consideration the temp. of the air layer between 200 and 100 mb. The results show that this temp. appears to be a factor closely controlling the meson intensity at the surface of the earth; the intensity increases with increasing temp. at the rate of 0·12% per °C. Other factors in determining the intensity are the mass of air and the height of the 100 mb level over the station. The corresponding coeffs. of absorption and decay prove to be comparable with those obtained from other measurements for mesons of the same momentum. It has also been found that the coexistence of the 3 effects permits explanation of the variability exhibited by the barometric coeff. when evaluated from short periods of observations. These results may therefore be taken as evidence that the bulk of mesons is produced at the height of 100 mb. If the positive effect of temp. is interpreted as the result of processes of decay and interactions with air nuclei of π-mesons at the production level, then the coeff. 0·12% per °C leads to a value of $4{\cdot}9\times10^{-8}$ sec for the upper limit of the mean life of π-mesons. A.

537.591 : 539.18

347. On the local production of mesons at 3 500 m altitude. B. D'ESPAGNAT AND C. PEYROU. *C.R. Acad. Sci., Paris*, **228**, 674–6 (*Feb.* 21, 1949) *In French.*

The backward projected mesons observed by Camerini *et al.* [Abstr. 3298 (1949)] are used as a basis to estimate the energy of the forward flux to be expected from comparable collisions. The collisions are for this purpose considered as between single nucleons, with all of the disposable energy passing to a single meson. J. G. WILSON

537.591.1

348. On the ratio of positive to negative particles in the vertical cosmic-ray beam at sea level. B. G. OWEN AND J. G. WILSON. *Proc. Phys. Soc., Lond. A*, **62**, 601–7 (*Oct.*, 1949).

A method of direct momentum measurement has been used to determine the ratio of positive to negative particles in the cosmic-ray beam at sea level. Measurements on about 12 000 particles give the ratio $+/- = 1{\cdot}268 \pm 0{\cdot}023$, and it is further shown that to the statistical accuracy of the experiment there is no variation of this ratio with momentum over the momentum range 10^9–10^{10} eV/c. A.

537.591.15

349. Observations on the first results of [cosmic ray] experiments carried out at the Pic du Midi. J. DAUDIN. "*Cosmic Radiation*," *London, Butterworth's Scientific Publications Ltd.; New York, Interscience Publications Inc.* (1949) 165–9. *In French.*

The theory of the absorption of Auger showers is discussed. Direct measurements on single particles are given, using counters with and without screens. The properties of the penetrating particles are compared with those of the single mesons of the cosmic rays, in particular, their ability to produce showers. It is shown that the penetrating particles in the air showers give rise to groups of easily absorbed particles. The barometer coeff. of the air showers is discussed. E. P. GEORGE

537.591.15

350. The physical significance of the index of the density distribution in Auger showers. J. DAUDIN. "*Cosmic Radiation*," *London, Butterworth's Scientific Publications Ltd.*; *New York, Interscience Publications Inc.* (1949) 171–6. *In French.*

Reviews the work of the French and Italian schools on the density distribution in air showers. The exponent, γ, of this distribution is not a constant, but varies with the size, separation and altitude of the counter systems. Observations on the influence of the goemetrical arrangement of the counters in a given group cast doubt on the validity of the usual assumption that the particles follow a Poisson distribution. The significance of the observed values of γ is discussed. E. P. GEORGE

537.591.15

351. Penetrating showers. W. B. FRETTER. *Phys. Rev.*, **76**, 511–17 (*Aug.* 15, 1949).

Penetrating showers produced in Pb have been observed in a large cloud chamber at sea level and 3 027 m. Observations made on the showers include frequency of occurrence, multiplicity, angular distribution and production of high energy electrons. An attempt is made to compare the numerical data obtained with predictions of various meson theories, assuming that the events are produced by high energy nucleons. A.

537.591.15

352. On penetrating showers in cosmic radiation. H. A. MEYER, G. SCHWACHHEIM, A. WATAGHIN AND G. WATAGHIN. *Phys. Rev.*, **76**, 598–601 (*Sept.* 1, 1949).

The mean range of the radiation that generates penetrating showers has been determined in the atmosphere and in water. The results are respectively ~ 120 g/cm^2 and ~ 55 g/cm^2. The relation between the observed variation of the frequency of penetrating showers with barometric pressure and the absorption law in air for the shower producing radiation has been discussed in some detail. The *E–W* asymmetry of the radiation that generates penetrating showers has been studied and the results were found to be negative within the experimental errors. The penetrating power of the penetrating showers produced in air has been investigated. No appreciable absorption has been found when the Pb protection of the counters has been increased from 18 to 28 cm. A.

537.591.15

353. Heavy particles in cosmic-ray stars. M. BLAU, M. M. BLOCK AND J. E. NAFE. Letter in *Phys. Rev.*, **76**, 860–1 (*Sept.* 15, 1949).

NTB plates, loaded with Bi, were exposed for 3 hr at 93 000 ft, at Minnesota (55° *N*). A star showing 3 nuclear fragments with $Z \geqslant 3$ is discussed. E. P. GEORGE

537.591.15

354. Energetic events in emulsions at high altitude. J. HORNBOSTEL AND E. O. SALANT. Letter in *Phys. Rev.*, **76**, 859–60 (*Sept.* 15, 1949).

Eastman *NTB*3 emulsions were exposed at 93 000 ft, near Cuba, 31° geomagnetic *N*, and 124 stars were observed associated with straight tracks near min. grain density. 47 events had 4 or more of these light tracks, and their general features are discussed. The frequency of stars with 5 or more branches is reported to be $3{\cdot}6 \pm 0{\cdot}4$ times greater at 57° than at 31° magnetic *N*. E. P. GEORGE

537.591.15

355. On the size-frequency distribution of penetrating showers. W. HEITLER AND L. JÁNOSSY. *Proc. Phys. Soc., Lond. A*, **62**, 669–83 (*Nov.*, 1949).

The relative number of showers containing n mesons when a fast primary nucleon hits a compound nucleus has been calculated on the assumption that in a single nucleon-nucleon collision only one meson is produced (pure plural production). The cross-section for meson production is assumed to have the form $\Phi(\varepsilon/E)d\varepsilon/E$, where E is the energy of the primary and ε the energy lost by it, but the absolute value of Φ and its dependence on ε/E are left open. The fluctuations of the shower size are duly taken into account. For comparison with experiments it is assumed that about $\frac{1}{2}$ the number of fast shower particles are fast protons as suggested by the positive excess of penetrating shower particles. The theoretical results depend on two constants, the total cross-section and some weighted average over the energy distribution $\Phi(\varepsilon/E)$. Choosing these suitably, the results are in good agreement with the relevant data within the experimental statistical errors, and the agreement extends also to the "large showers" with $\simeq 20$ thin tracks. The values of the constants thus determined are physically reasonable. It is concluded that the size-frequency distribution of penetrating showers can be fully understood on the basis of pure plural production, but some—small or large—contribution from multiple processes cannot be excluded. A.

537.591.5

356. Evidence of an E–W asymmetry in the direction of isolated tracks due to cosmic rays. M. MORAND. *C.R. Acad. Sci., Paris*, **228**, 1488–90 (*May* 9, 1949) *In French.*

A considerable *E–W* asymmetry observed for tracks in photographic emulsion exposed at up to 2 300 m altitude in low magnetic latitudes is attributed mainly to protons connected in direction with the initial primaries. These protons may have traversed much of the atmosphere as neutrons. J. G. WILSON

537.591.5

357. Study of E–W asymmetry shown by isolated tracks in photographic emulsions, and the demonstration of the existence of a heavy meson. M. MORAND. *C.R. Acad. Sci., Paris*, **229**, 40–2 (*July* 4, 1949) *In French.*

Boron loaded plates exposed at 4 500 m on the geomagnetic equator exhibit an *E–W* asymmetry for single tracks which is compared with measurements at lower altitudes. The total asymmetry diminishes rapidly with height and the zenith angle of max. asymmetry increases with altitude to 70° at 4 500 m. The asymmetry is attributed to a component, diluted at all heights by isotropic production, derived directly from magnetic field sensitive primaries. Reasons are given for supposing these particles to be heavy mesons ($m \sim 1\,000\, m_0$). J. G. WILSON

537.591.5

358. On the latitude dependence of nuclear disintegration and neutrons at 30 000 feet. J. A. Simpson, Jr. and R. B. Uretz. Letter in *Phys. Rev.*, **76**, 569–70 (*Aug.* 15, 1949).

Nuclear disintegrations $> 5{\cdot}8$ MeV were recorded by means of fast ion chambers flown at 30 000 ft at N magnetic latitudes 40° and 55°. The factor of increase was found to be $\sim 1{\cdot}5$, very close to the increase of both slow and fast neutrons, which was measured simultaneously. Concludes that most of the neutrons in the atmosphere < 20 MeV are derived from nuclear disintegration stars. E. P. GEORGE

537.591.5

359. Altitude dependence of mesons of energy between 224 and 255 MeV. M. Conversi. Letter in *Phys. Rev.*, **76**, 849–50 (*Sept.* 15, 1949).

Mesons passing through 15 cm of Pb and stopping in 10 cm of graphite were recorded by delayed coincidences. The decay curves were measured at heights up to 36 000 ft, and are all consistent with a decay constant of $2{\cdot}2$ μsec. The number of slow mesons varies exponentially with atmospheric depth expressed in gm/cm², the absorption length being 280 ± 10 gm/cm². E. P. GEORGE

537.591.5

360. Altitude dependence of penetrating particles slowed down after traversing 15 cm of lead. M. Conversi. Letter in *Phys. Rev.*, **76**, 851 (*Sept.* 15, 1949).

The charged particles stopped in Pb are separated into 2 groups of: (*a*) μ-mesons, recognized by delayed-coincidence techniques, and (*b*) the remainder (called the X-component). Measurements on these 2 components have been made at heights up to 36 000 ft. The absorption length of the X-component is 150 gm/cm², and it is thought to consist of protons. E. P. GEORGE

537.591.8

361. Showers of mesons in disintegrations produced by cosmic rays. C. Peyrou, B. d'Espagnat and L. Leprince-Ringuet. *C.R. Acad. Sci., Paris*, **228**, 1777–80 (*June* 8, 1949) *In French.*

A theoretical discussion of the nuclear disintegrations found in electron-sensitive photographic plates, which are associated with groups of tracks near minimum grain-density. On the basis of the general assumption that the "minimum" tracks in a group are all mesons produced in a single act, formulae are given for the angular spread, energy, etc., of the mesons in terms of the energy of the primary nucleon. E. P. GEORGE

537.591.8

362. Large cosmic stars in electron sensitive emulsions. E. Pickup and L. Voyvodic. Letter in *Phys. Rev.*, **76**, 447–8 (*Aug.* 1, 1949).

A large star (31 prongs) in an electron sensitive emulsion exposed 185 hr at 14 000 ft, shows a strongly collimated downward directed cone of lightly ionizing tracks. J. G. WILSON

537.591.8

363. On the knock-on secondaries of penetrating particles. W. W. Brown, A. S. McKay and E. D. Palmatier. *Phys. Rev.*, **76**, 506–10 (*Aug.* 15, 1949).

The knock-on secondaries of penetrating particles emerging from Pb plates (15 g cm^{-2}) have been investigated by cloud chamber and by counter telescope. The frequency of occurrence and the observed spatial distribution of the secondaries with respect to the primary penetrating particles have been found to be in agreement for the two different methods. Further data are presented on the back scattering of secondaries in Pb plates and on the emergence of secondaries from thin pieces of wood and counter walls. The possible effects on counter experiments are discussed briefly. A.

537.591.8

364. On the mechanism of production of the neutron component of the cosmic radiation. V. Cocconi Tongiorgi. *Phys. Rev.*, **76**, 517–26 (*Aug.* 15, 1949).

Experiments have been performed on the neutron component of the cosmic radiation, with a system of BF_3 proportional counters embedded in paraffin, capable of recording neutrons in the energy range between ~ 2 and ~ 15 MeV. The neutron rate recorded with such a detector is due to both neutrons locally produced inside the detector and neutrons produced outside the detector, i.e. in the surroundings and in the atmosphere. The local neutron production is due to a radiation which in the great majority does not consist either of photons or μ-mesons. The intensity of such a radiation increases with altitude with a mean free path in air of 120–130 g/cm², which is confirmed by the fact that it shows a barometric coefficient $\simeq -11\%$ per cm Hg. At mountain elevation (4 000 m) the intensity of this radiation is close to that of the total ionizing cosmic radiation. This suggests that it consists principally of fast neutrons. The locally produced neutrons are mostly produced in multiples, with multiplicity depending upon the material. In Pb the average multiplicity observed was ~ 8, in C < 2. The rates of neutron production in different materials are satisfactorily described by a cross-section $\propto$ the $\frac{2}{3}$ power of the mass number of the material. The results indicate that the main source of all the neutrons present in the cosmic radiation are "stars," though high energy processes like penetrating and extensive showers do contribute to neutron production. A.

537.591.8 : 539.18

365. Production of heavy mesons in cosmic ray stars. J. B. Harding and D. H. Perkins. Letter in *Nature, Lond.*, **164**, 285–7 (*Aug.* 13, 1949).

The production of stars in a photographic emulsion is compared with the frequency of π-meson tracks ending in the emulsion at 3 650 m altitude up to absorbing depths of 5 m ice. The constancy of the ratio π-mesons stopping/stars formed at depths > 200 g/cm² is consistent with the view that π-mesons are derived from stars. Assuming the rate of meson formation at any depth to be $\propto$ the rate of star formation, the mesons and their primaries to be moving vertically (correction applied for upward moving mesons), and the energy loss of π-mesons to be by ionization only, the average number of π-mesons formed per star is shown to be about $0{\cdot}1$, the average energy to be between 250 and 600 MeV, and the range for nuclear stopping of π-mesons to be $>$ 120 g/cm². J. G. WILSON

MAGNETISM 538

538.082.74

366. A permeameter for determining the magnetization curve of iron specimens for high magnetic flux densities. H. BLOMBERG. *Tied. Valt. Tekn. Tutkimuslaitos* (*No.* 64) 3–28 (1948) *In Finnish.*

Describes a permeameter for range $H = 10^3$ to 3×10^5 A/m. The permeameter is a yoke device, generally in accordance with Grumlich's known "isthmus"-principle. The determination of flux density and field strength has been concentrated to the middle portion of the specimen affecting a short part only of the free length of the specimen. The specimen has been divided into 2 equal halves placed alongside of each other with an air-gap of 3 mm between. A flat H-coil is inserted into this gap for the measurement of the field strength. The author gives some information as to the investigation of the errors inherent in this method, and discusses the magnitude of these errors. For normal dynamo sheet and a field strength range of 10^4 to 3×10^5 A/m these errors amount to at most 0·5% in the field strength corresponding to about 0·05% in the flux density. For a field strength range of 10^3 to 10^4 A/m, comparison with a magnetizing curve obtained by means of a ring specimen indicates that the errors are negligible. Finally the possibility of enlarging the range of measurement from $H = 10^3$ A/m downwards is discussed. A.

538.114

367. The present status of the theory of ferromagnetism. J. H. VAN VLECK. *Physica*, **15,** 197–206 (*April*, 1949) *In English.*

A critical review is given starting from the original theories of Weiss and Heisenberg and giving an account of the phenomena which they explain. The refinements introduced are discussed but the basic limitation of the assumption that there is an integral number of firmly bound electrons to each atom is stressed. The free electron theory as developed by Stoner [see Abstr. 1386 (1939), 2167 (1938)] and others is next reviewed and it is suggested that a treatment somewhere between the free and bound electron theories may be the most satisfactory. A concluding reference is made to recent experimental measurements on microwave absorption and their implication on future theoretical work is discussed.

G. F. HODSMAN

538.114

368. Ferromagnetic domains. R. M. BOZORTH. *Physica*, **15,** 207–19 (*April*, 1949) *In English.*

A review is given of quantitative aspects of domain theory resulting from considerations of the forces involved and formulation of the corresponding energies. Satisfactory comparison between theory and experiment is shown in the case of the approach to saturation by domain rotation and also for domain structure in unmagnetized or weakly magnetized material—interpretation of powder patterns being described. Reference is made to the discrepancy between domain volumes estimated from powder patterns and deduced from measurements on the Barkhausen effect. G. F. HODSMAN

538.114

369. A quantitative examination of recent ideas on domain structure. L. F. BATES AND F. E. NEALE. *Physica*, **15,** 220–4 (*April*, 1949) *In English.*

The spacing of parallel straight line deposits of colloidal magnetite on the surface of a single crystal of Si–Fe in the form of a thin strip, was measured for different values of a magnetic field applied parallel to the binary axis. The most satisfactory results were obtained after the specimen had been annealed at 900°C *in vacuo* for 1 hr and then allowed to cool slowly. The results are in general agreement with the theoretical predictions of Néel [*J. Phys. et le Radium* (*Sér.* 8) **5,** 241 (1944)] in the region of 50 to 400 oersted. G. F. HODSMAN

538.114

370. New theory of the coercive field. L. NÉEL. *Physica*, **15,** 225–34 (*April*, 1949) *In French.*

Earlier theories are critically discussed and their inability to explain high coercive fields is stressed. In the theory described, coercive fields are attributed to the presence of cavities or inclusions or deviations from preferred directions of magnetization produced by internal strains. The coercive field is calculated as a function of the volume of the inclusions, the internal strains and the volume affected by these strains. The greater importance of inclusions in affecting the coercive field of Fe as compared with Ni is shown and concord with experimental results for Fe alloys is obtained. Finally the factors influencing the coercive field in the region of the Curie point are discussed.

G. F. HODSMAN

538.12

371. A device for maintaining a constant magnetic field. H. NAUMANN. *Z. angew. Phys.*, **1,** 260–4 (*Jan.*, 1949) *In German.*

Fields of the order of the earth's field are held closely constant by compensating variations in intensity and direction by means of coils, the currents in which are controlled by reflecting variometers through photo-cells and amplifiers. C. E. WEBB

538.22

372. Proximity effects in the measurement of magnetic susceptibility. M. C. STEELE. Letter in *Phys. Rev.*, **76,** 566 (*Aug.* 15, 1949).

The susceptibility of an assembly of small superconducting Pb spheres (diameters of order 1 mm) dispersed in vaseline was found to depend linearly on the volume concentration of Pb, due to proximity effects. For 9% volume concentration of Pb the susceptibility was reduced by 3%. D. SHOENBERG

538.22 : 530.145

373. A note on the quantum theory of ferromagnetic resonance. J. M. LUTTINGER AND C. KITTEL. *Helv. Phys. Acta*, **21** (*No.* 6) 480–2 (1948) *In German.*

It is shown that the quantum theory of ferromagnetic resonance leads to the same result as the classical calculation. A. E. DE BARR

538.221

374. Time-effects in ferromagnetism. J. L. SNOEK. *Physica*, **15,** 244–52 (*April*, 1949) *In English.*

Ionic effects in Fe involving interstitial diffusion of C and N can be interpreted in terms of Bloch wall movements and lead to explanation of magnetic

viscosity effects in terms of a single time constant. Certain ferrites show analogous time effects of unknown origin, but apparently involving several time constants. Electronic effects in Fe are exemplified by ferromagnetic resonance and by the effect of eddy currents on apparent magnetic properties.

N. F. ASTBURY

538.221

375. On the Gorter normal field ferromagnetic resonance experiment. C. KITTEL, W. A. YAGER AND F. R. MERRITT. *Physica*, **15**, 256–7 (*April*, 1949) *In English.*

Brief reference is made to experiments using Supermalloy at 23 970 Mc/s with the applied static field both parallel and normal to the plane of the specimen. The results may be interpreted as demonstrating the reality of the high values of the gyromagnetic ratio found in microwave resonance absorption experiments. G. F. HODSMAN

538.221

376. Magnetic behaviour of ferromagnetics at high frequencies. H. J. VAN LEEUWEN. *Physica*, **15**, 258–63 (*April*, 1949) *In English.*

A critical review is given of the theories of permeability dispersion at high frequencies and a possible explanation of the discrepancy between the theoretical curves and experimental values is briefly indicated.

G. F. HODSMAN

538.221 : 538.566.2

377. On the theory of ferromagnetic resonance. D. POLDER. *Physica*, **15**, 253–5 (*April*, 1949) *In English.*

A method of calculation is outlined which does not involve explicitly the shape of the body and which leads to the expressions derived by Kittel [see Abstr. 1574 (1947), 1273 (1948)] for the dependence of the resonance frequency on the shape of the specimen. Reference is also made to the calculation of the index of refraction of an e.m. wave propagating through a non-conducting magnetized ferromagnetic material. Classical equations of motion have been used but are justified from quantum mechanical considerations, which also suggest a possible explanation for the discrepancy observed when the gyromagnetic ratio is determined by resonance experiments.

G. F. HODSMAN

538.221 : 621.318.2

378. The principal work in ferromagnetism since about 1938. W. SUCKSMITH. *J. Iron Steel Inst.*, **163**, 51–6 (*Sept.*, 1949).

A critical review with 105 references.

538.222

379. Feeble paramagnetism of chromium trioxide and potassium chromate. D. S. DATAR AND S. S. DATAR. *Indian J. Phys.*, **23**, 153–60 (*April*, 1949).

It has been shown that the partial freedom of the electronic spin due to imperfect pairing accounts for the paramagnetism exhibited by hexavalent Cr ions in ^1S state. The imperfect pairing is due to the partially covalent bonding of electrons between Cr and O in CrO_3 and chromate radical. The factor for the unpaired spin was calculated using diagrams constructed on the basis of the known X-ray data and ionic radii assuming spherical charge distribution for the electron. The factor in both cases works out to be about 6%. The values for the paramagnetic susceptibility of CrO_3, K_2CrO_4 and Na_2CrO_4 calculated using this factor show remarkable agreement with the values obtained from the experimentally observed specific susceptibility for the above compounds. A.

538.222

380. Magnetic susceptibilities of some tetravalent uranium fluorides. N. ELLIOTT. Letter in *Phys. Rev.*, **76**, 431–2 (*Aug.* 1, 1949).

The magnetic susceptibilities of UF_4, KUF_5, K_2UF_6 and Na_3UF_7 were measured by the Gouy method between approximately 74°K and 300°K. The Curie–Weiss law is obeyed over the whole temp. range, except for K_2UF_6 for which it fails below 198°K. Values of the Curie constant, C, negative Curie temperature, θ, and Bohr magneton number, μ, are given; the observed values of μ are in reasonable agreement with that calculable for a free ion in a $^3H_4$ state, corresponding to two $5f$ electrons, but the observed θ values are so large that it is questionable whether the Curie constant may be given its usual interpretation. An error in a previous article [Abstr. 258 (1949)] is corrected. E. P. WOHLFARTH

538.222 : 539.133

381. The energy levels of $Gd_2(SO_4)_3 . 8H_2O$ in a magnetic field. J. DE BOER AND R. VAN LIESHOUT. *Physica*, **15**, 569–80 (*July*, 1949) *In English.*

The energy levels of the salt $Gd_2(SO_4)_3 . 8H_2O$ have been calculated theoretically, taking into account the combined action of the cubic crystalline field and of the external magnetic field. The secular problem of the 8th degree has been solved for all values of the magnetic field for orientations [001], [110] and [111] with respect to the cubic crystalline field. For weak and for strong fields formulae are given, from which the energy levels can be determined for any direction of the magnetic field. The calculated microwave resonance absorption spectrum for magnetic dipole transitions in strong fields appears to depend strongly on the orientation of the magnetic field. A.

538.224 : 536.48

382. Magnetic susceptibility of zinc at liquid hydrogen temperatures. J. A. MARCUS. *Phys. Rev.*, **76**, 413–16 (*Aug.* 1, 1949).

The magnetic susceptibility of Zn has been investigated down to liquid H temps. in fields ranging from 3 to 10·5 kilogauss. Measurements were made on single and polycrystalline specimens by the Faraday method. At 20°K, the susceptibility $\parallel$ to the hexagonal axis shows a marked field dependence similar to that found by de Haas and van Alphen for the susceptibility of Bi $\perp$ to the trigonal axis. Maxima were observed at 4·1, 5·6 and 9·8 kilogauss; minima at 4·8 and 7·1 kilogauss. The amplitude of the oscillations decreases with temp. increase but some field dependence persists to 64°K. The susceptibility in a plane $\perp$ to the hexagonal axis remains isotropic down to the lowest temp. investigated (14°K) and is independent of the field. Oscillations in susceptibility characteristic of the de Haas–van Alphen effect were not observed in measurements on a polycrystal. The results are compared with those

for Bi, and it is noted that the observation of the de Haas–van Alphen effect in Zn supports the view that this effect is closely related to the anomalous field dependence of resistance which has been previously observed for both metals at low temps. A.

538.224

383. Diamagnetic susceptibilities of mercuric and mercurous ions. M. PRASAD, S. S. DHARMATTI AND A. K. GHOSE. *J. Chem. Phys.*, **17**, 819–25 (*Sept.*, 1949).

Magnetic susceptibilities of a number of pure mercuric and mercurous salts of inorganic and organic acids have been measured and it has been shown that Ikenmeyer's relation does not hold true in these compounds. A linear relation has been established between the molecular susceptibilities of salts of Mg, Zn, Cd and Hg (*ic*) containing the same anion and the number of electrons contained in the cations. The significance of this relation is discussed in detail primarily with a view to finding out the susceptibilities of mercuric and mercurous ions. A.

538.245

384. A study of magnetic viscosity. R. STREET AND J. C. WOOLLEY. *Proc. Phys. Soc., Lond. A*, **62**, 562–72 (*Sept.*, 1949).

A general analysis of magnetic viscosity based on activation energy concepts is given. A particular case is considered of the application of the theory to the phenomenon occurring in materials in which bulk magnetization proceeds by the rotational movement of the vectors of single domains, which process, according to a recent theory of Stoner and Wohlfarth, may occur in certain high coercivity alloys. Experiments have been made, using a magnetometer method, with specimens of alnico maintained at various temps. within the range −187°C to 250°C. The results obtained are found to be in good agreement with the theoretical analysis. A.

ELECTROMAGNETISM . ELECTRODYNAMICS
538.3/.5

538.3

385. Operational method applied to the equations of electrodynamics in a finite three-dimensional space. E. A. MEEROVICH. *Izv. Akad. Nauk, SSSR, Otdel Tekn. Nauk* (*No.* 2) 186–91 (*Feb.*, 1949) *In Russian.*

Errors of too many limiting conditions and also of misuse of even and odd functions in Maxwell's equations for electromagnetic and magnetic fields are criticized in Adler's "Three dimensional Fourier-transforms and their application to Maxwell's equations" [Abstr. 366 (1946)]. Maxwell's equations for these fields in uniform dielectric are transformed into operational form. This is used in the analysis of vibrations of a resonator in a parallelepiped form.

J. LUKASZEWICZ

538.3 : 530.12

386. Radiation from a uniformly accelerated charge. D. L. DRUKEY. *Phys. Rev.*, **76**, 543–4 (*Aug.* 15, 1949).

It has been stated that there is no radiation from a charge moving in the relativistic equivalent of uniform acceleration. This proves to be not the case when means of measuring the radiation are used which are suitable to the infinite extent of the path. The fields for a uniformly accelerated charge as deduced by conformal transformation from rest are found to correspond to ½ the sum of advanced and retarded potentials for two charges. A.

538.3 : 530.12

Kron's non-Riemannian electrodynamics. *See Abstr.* 44

538.3 : 530.145

Quantum electrodynamics. I. *See Abstr.* 52–3

538.3 : 530.145.6

Vacuum polarization and the photon self-energy. *See Abstr.* 61

538.561 : 621.396.611

387. Theory of electromagnetic oscillation on plate conductors. T. SAKURAI. *J. Phys. Soc. Japan*, **3**, 139–43 (*March–June*, 1948).

The theory of oscillations on plate conductors is developed. The wave functions, the properties of the field and the excitation of oscillating modes by an external field are discussed. A. H. W. BECK

538.566

388. On the electromagnetic surface wave of Sommerfeld. T. KAHAN AND G. ECKART. *Phys. Rev.*, **76**, 406–10 (*Aug.* 1, 1949).

It is proved that Sommerfeld's well-known electromagnetic surface wave does not exist in the radiation of a Hertzian dipole over a plane earth because it does not fulfil the so-called "radiation condition." The path of integration chosen by Sommerfeld is correct, but there is another saddle-point overlooked by this author which just annuls the surface wave due to the residue. These results are in agreement with Burrow's measurements. A.

538.566 : 621.392.26

389. Notes on "wave guides for slow waves." W. WALKINSHAW. Letter in *J. Appl. Phys.*, **20**, 634–5 (*June*, 1949).

It is shown that the results of Brillouin [Abstr. 2026 (1949)] can be much improved by a less stringent approximation in the matching process. Agreement between theory and measured values is excellent.

A. H. W. BECK (R)

538.566 : 621.392.26

390. Metal waveguide with parallelogram cross-section. R. MALVANO. *Nuovo Cim.* (*Ser.* 9) **6**, 265–73 (*July*, 1949) *In Italian.*

Theoretical formulae are given for the propagation constant, attenuation, field components, etc., both for *E*- and *H*-waves, and possible applications are discussed. L. PINCHERLE (R)

538.566 : 621.392.26 : 621.317.763

391. Wave-guide interferometers as differential wave-meters. A. B. PIPPARD. *J. Sci. Instrum. Phys. Ind.*, **26**, 296–8 (*Sept.*, 1949).

The advantages of non-resonant waveguide interferometers over resonant cavities as absolute differential wave-meters are discussed, and two simple interferometers are considered in detail. It is shown that an interferometer employing a "magic-T,"

and operating in a manner similar to Michelson's optical interferometer, is capable of extremely high sensitivity in detecting small changes of frequency, and experimental results are quoted to support this view. A.

538.566 : 621.396.11

392. Influence of refractive index on the radio frequency emissions of an ionized medium. J.-F. DENISSE. *C.R. Acad. Sci., Paris*, **228**, 751–3 (*Feb.* 28, 1949) *In French.*

Short note pointing out that it is incorrect to assume that the refractive index of a radiating ionized medium can be considered unity for the radiations concerned. A correct treatment of the problem is outlined. W. J. G. BEYNON (R)

538.566 : 621.396.611.4

393. Mathematical theory of hollow cylindrical resonators excited by a Hertzian dipole. F. DE SIMONI. *Comment. Pont. Acad. Sci.*, **9** (*No.* 12) 491–513 (1945) *In Italian.*

538.566 : 621.396.671 : 621.392.26

394. Electromagnetic radiation from waveguides and horns. L. LEWIN. Letter in *Nature, Lond.*, **164**, 311 (*Aug.* 20, 1949).

A method of Levine and Schwinger is used to solve the integral equations of radiation from waveguides. Results for an unflanged guide and for an unflanged horn in a cheese mirror are given. A. H. W. BECK (R)

538.566 : 621.396.671.4

395. A study of the e.m.f. method. C. T. TAI. *J. Appl. Phys.*, **20**, 717–23 (*July*, 1949).

An investigation of the e.m.f. method to determine the input impedance of a thin biconical aerial as first suggested by Schelkunoff [Abstr. 355 B (1942)]. By considering the various components of the currents flowing on the aerial, it has been shown that the sinusoidal part is, indeed, the dominating component among all these currents. An investigation of the total current at the end of the aerial, where the lateral surface of the cone and the spherical cap meet, shows that the current is not identically zero at that point, but vanishes as the reciprocal of the square of the characteristic impedance of the cone. The two approximate expressions of the complex conjugate power used in the e.m.f. method are derived, as well as the exact expression. Some integrals occurring in the formulation are also computed in detail to show the various approximations involved. A.

538.566.2

396. The magnetic dipole in an atmosphere having spherically symmetrical stratification. G. ECKART. *C.R. Acad. Sci., Paris*, **228**, 1279–80 (*April* 11, 1949) *In French.*

Expressions are found for the electromagnetic field due to a magnetic dipole oscillator situated in an atmosphere having a dielectric constant of the form $\alpha + \beta/r$, and uniform permeability.

P. M. DAVIDSON

538.566.2

397. Tensor field equations in a region of variable refractive index. P. D. P. SMITH. Letter in *J. Appl. Phys.*, **20**, 633 (*June*, 1949).

Maxwell's equations are put into tensor form for use in a medium of varying permittivity and magnetic permeability. In this form they are most readily adapted to different co-ordinate systems.

L. S. GODDARD

538.566.2 : 537.533 : 621.392.2 : 621.396.11

398. Wave amplification by interaction with a stream of electrons. J. A. ROBERTS. *Phys. Rev.*, **76**, 340–4 (*Aug.* 1, 1949).

A discussion is given of the propagation of plane electromagnetic waves in a uniform, ionized medium, in which the electrons possess a mean drift velocity. The treatment is based on the general theory developed by Bailey. It is shown that, for frequencies below a certain critical frequency (of the same order as the electron plasma frequency), one of the 8 possible waves in general grows in amplitude as it progresses through the medium. The relation of this result to the theories of solar noise and of the travelling-wave tube amplifier is discussed. A.

538.566.2 : 621.392.2

399. Diffraction of a spherical electromagnetic wave by a thin spherical segment. R. G. MIRIMANOV. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 1) 65–7 (1949) *In Russian.*

By means of a system of coordinates in which the spherical segment which diffracts an electromagnetic wave, the length of which is considerably less than the dimensions of the segment, is so placed that its centre coincides with the initial point of the co-ordinates, the dipole terms are computed at this centre. The conductivity of the segment is taken as finite. Formulae can then be found for determining (1) the scalar potential at any point of the area surrounding the spherical segment, (2) the components of the vector of electric and magnetic tensions of the diffraction field, wherever the tensor forces act. Formulae are quoted for (*a*) the case of an electrical (Type *E*) wave, and (*b*) a magnetic (Type *H*) wave.

J. CLEUGH

538.566.2 : 621.396.11

400. The propagation of electromagnetic waves in a stratified medium. I–II. G. ECKART. *Ann. Télécommun.*, **4**, 142–54 (*May*); 223–30 (*June*, 1949) *In French.*

A comprehensive mathematical paper on the propagation of electromagnetic waves in a medium in which the permittivity varies linearly in one direction. In II consideration is given to the case of weak permittivity gradients and also to the theory of the surface wave in a stratified medium.

W. J. G. BEYNON (R)

538.566.2 : 621.396.11

401. Tropospheric effects in ionosphere-supported radio transmission. G. W. PICKARD AND H. T. STETSON. *Proc. Inst. Radio Engrs*, **37**, 596–9 (*June*, 1949).

More extended observations of meteorological effects in tropospheric transmission in the 40 to 50 Mc/s band, recently analysed, substantiate high correlations with temp., atmospheric refraction and wind direction. Since ionospheric-supported transmissions must pass at least twice through the troposphere, investigations have been made for possible meteorological effects at frequencies from the broadcast band to 10 Mc/s and comparisons made with

known tropospheric reception at frequencies in the 40–50 Mc/s band. Correlation coefficients as high as $0{\cdot}8 \pm 0{\cdot}1$ are shown. Reception from WBBM, Chicago, 850 miles distant, based on 3 years' data, shows a direct correlation with surface refraction and with atmospheric temp. changes. Night fields rise from a min. one day before a temp. rise equal to 10°F to a max. on the day such temp. change occurs. Similarly, a drop in field occurs one day prior to an equal temperature fall. Studies of reception at Needham of WWV, 5 Mc/s (Beltsville, Md.), 373 miles distant, show similar correlations as those determined for the broadcast band. Furthermore, night fields of WWV, 5 Mc/s, tend to a max. one day preceding a prevailing S.E. wind directed broadside to the transmission path. Little correlation was found with N.E. winds directed along the path. Variations in field intensities range from 15–30% of mean fields, dependent upon meteorological conditions at the receiving end. Such variations may be attributed to atmospheric bending, reflection transmissions due to changing lapse rate at the lower atmospheric levels, and possibly to as yet undetermined troposhere-ionosphere relations. A.

538.566.2 : 621.396.11.029.64

402. Absorption and reflexion of U.H.F. waves (300–500 Mc/s) by seawater. S. K. Chatterjee and B. V. Sreekantan. *Indian J. Phys.*, **23**, 273–9 (*June*, 1949).

Deals with the absorption and reflection suffered by 300–500 Mc/s waves while travelling in a soln. of a mixture of electrolytes simulating sea water. Experimental results indicate max. absorption at 380 Mc/s and very little variation of the reflection coefficient over the frequency range in question. It has also been observed that permittivity and conductivity increase with increasing frequency of the incident wave. A.

MAGNETIC EFFECTS 538.6

538.61

403. On the magnetic rotatory power of fluorine. R. de Mallemann and F. Suhner. *C.R. Acad. Sci., Paris*, **229**, 330–1 (*Aug.* 1, 1949) *In French.*

F has a positive rotativity which is $\ll$ that of the other halogens. Measurements with CF_2Cl_2 give a value of $0{\cdot}55 \times 10^{-5}$ (rad.). [See Abstr. 4469 (1938), 1609 (1939)]. H. G. Jerrard

538.63 : 537.312.62

Fundamental considerations on the behaviour of a superconductor in a magnetic field. *See Abstr.* 281

538.63 : 537.312.62

Magnetic effects of a rotating superconductor. *See Abstr.* 282

538.63 : 537.312.62

The superconducting torus. *See Abstr.* 283

538.632 : 537.311.33

Hall-effect of metal-semiconductor point contacts. *See Abstr.* 270

538.65 : 539.31

Internal friction due to ferromagnetism. *See Abstr.* 541

538.652

404. The cause of anisotropy in permanent magnet alloys. K. Hoselitz and M. McCaig. *Physica*, **15**, 241–3 (*April*, 1949) *In English.*

Differences between longitudinal and transverse magnetostriction coeffs. of magnetically annealed alloys and those of isotropic alloys can be explained if it be assumed that the domains in the former are everywhere magnetized along the cube axis nearest the direction of the field applied during cooling, but anisotropy of magnetization energy must depend also on other factors such as crystal energy, stress distribution and shape anisotropy of precipitates. N. F. Astbury

538.652

405. The magnetostriction of anisotropic permanent magnet alloys. M. McCaig. *Proc. Phys. Soc., Lond. B*, **62**, 652–6 (*Oct.*, 1949).

Blocks of permanent magnet alloys of the system Fe-Ni-Al-Co-Cu have been prepared with columnar crystals. The magnetostriction has been measured in various directions before and after heat treatment in a magnetic field. The results agree well with those predicted theoretically, and so confirm the postulated crystal structure. A.

538.653.11

406. Some effects of tension on magnetization processes. K. H. Stewart. *Physica*, **15**, 235–40 (*April*, 1949) *In English.*

Shows that the transverse demagnetizing coeff. must be taken into account and that the magnetization curve of a single crystal under tension must consist of an initial region of low susceptibility, followed by a vertical rise to the knee at a critical field determined by the tension, orientation of the crystal and magnetization coeff. Qualitative confirmation is provided by experiments on high-oriented polycrystalline specimens. N. F. Astbury

538.69 : 532.59

Experimental demonstration of magneto-hydrodynamic waves. *See Abstr.* 81

MOLECULAR AND ATOMIC STRUCTURE 539.1

539.1 : 53.081.6

The atomic constants. *See Abstr.* 35

THEORY OF SOLID STATE 539.11

539.11 : 548.7

407. Electronic eigenfunctions in ionic crystals. R. Nosawa. Letter in *Phys. Rev.*, **75**, 1102–3 (*April* 1, 1949).

The Wigner–Seitz method has been improved along lines suggested by the work of Von der Lange and

Bethe [Abstr. 1918 (1947)] using (*a*) a potential with the crystal symmetry and allowing for nearest neighbour, and (*b*) better boundary conditions.

G. J. KYNCH

MOLECULAR STRUCTURE 539.13

539.13 : 535.343.4–14

408. The microwave spectrum of $CF_2{=}CH_2$. A. ROBERTS AND W. F. EDGELL. Letter in *J. Chem. Phys.*, **17**, 742–3 (*Aug.*, 1949).

Preliminary identification of lines with the aid of the Stark effect give $I_a = 76{\cdot}257$, $I_b = 80{\cdot}450$ and $I_c = 156{\cdot}946 \times 10^{-40}$ g cm² when *a* is the figure axis. Dipole moment 1·366 *D*. D. H. WHIFFEN

539.132

409. Electron deficient compounds. II. Relative energies of "half-bonds." R. E. RUNDLE. *J. Chem. Phys.*, **17**, 671–5 (*Aug.*, 1949).

It is suggested that the tendency to make use of all low energy orbitals is the underlying principle of electron-deficient bonding. Simple theoretical arguments, limited to the special case of 2 electrons and 3 orbitals, are given to show that this principle is a direct consequence of quantum-mechanical theories of valence. 2 half-bonds are shown to be of lower energy than a single bond plus an unused low energy orbital in most cases. The tendency to form half-bonds should be most important in symmetrical cases, and particularly where the electronegativities of all atoms involved are equal, e.g. the boron hydrides and H_3^+. Certain consequences of the proposal to the fields of organo-metallic compounds, catalysis and molecular rearrangements are pointed out. It is suggested that at low temps. complexes may exist between molecules with excess orbitals and molecules with no unshared pairs. A.

539.132

410. Vibration frequencies and binding forces in some silicate groups. F. MATOSSI. *J. Chem. Phys.*, **17**, 679–85 (*Aug.*, 1949).

Frequency formulae for some atomic groups occurring in silicates (Si_2O_7, Si_3O_9 ring, SiO_3 chain, SiO_2 network) are computed, using simplified force systems, and force constants are calculated. The strong force between the O atoms connecting the SiO_4 groups of the Si_3O_9 ring is especially remarkable. Further observations are necessary to indicate the choice of less simple force systems. A.

539.132

411. Punched card calculation of resonance energies. M. B. OAKLEY AND G. E. KIMBALL. *J. Chem. Phys.*, **17**, 706–17 (*Aug.*, 1949).

The calculation of resonance energies can be greatly simplified by using punched card machines. Two methods are developed. The first is easy to apply and works well for 8-, 10- and 12-electron problems. This is used for naphthalene. The results lend themselves well to a bond probability calculation from which bond distances in good agreement with other methods are obtained. The second procedure is longer, but makes possible the calculation of anthracene and phenanthrene resonance energies. These are $-2{\cdot}95_1\alpha$ and $-3{\cdot}01_9\alpha$, respectively. Bond probabilities and lengths were also calculated from these data. A.

539.132

412. Molecular orbital calculations of vibrational force constants. II. The ring-twisting constants of benzene. B. L. CRAWFORD, JR. AND R. G. PARR. *J. Chem. Phys.*, **17**, 726–33 (*Aug.*, 1949).

Two out-of-plane bending force constants of the C_6 framework of benzene are calculated by the method of antisymmetric molecular orbitals, and the values obtained compared with those previously determined from spectoscopic data. A.

539.132

413. The normal vibrations of polyatomic molecules as calculated by Urey–Bradley field. II. Vibrations of polythene, ethane and their deuterium compounds. T. SIMANOUTI. *J. Chem. Phys.*, **17**, 734–7 (*Aug.*, 1949).

[See Abstr. 4105 (1949)]. Assuming the Urey–Bradley field as the type of intramolecular potential, equations to calculate 5 optically active frequencies of polythene molecule were derived. If force constants $K_{CH} = 4{\cdot}2$, $H_{HCH} = 0{\cdot}15$, $F_{HH} = 0{\cdot}1$, $F_{HC} = 0{\cdot}4$, $F_{HH'} = 0$ and $F_{HC'} = -0{\cdot}05$ (10^5 dynes/cm) are assumed, the observed frequencies of $(CH_2)_n$ and $(CD_2)_n$ as well as those of CH_4, CD_4, C_2H_6, C_2D_6, etc., were explained satisfactorily. A.

539.132

414. The asymmetric rotor. VII. Extension of the calculation of energy levels. R. M. HAINER, P. C. CROSS AND G. W. KING. *J. Chem. Phys.*, **17**, 826–36 (*Sept.*, 1949).

Various methods of computing the energy levels of the asymmetric rotor are reviewed for values of high angular momentum which are required in the interpretation of infrared and micro-wave spectra. A table of values of $J = 11$ and 12 is given and over the whole range of asymmetry $-1 \leqslant \kappa \leqslant 1$. Methods of using the Correspondence Principle, Mathieu functions, harmonic oscillator matrices, and power series expansions are discussed, and the survey indicates there is always a region of some degree of asymmetry where the exact value has to be obtained from the rigorous matrix-mechanical formulation. Methods of obtaining energy values for small intervals in κ from existing tables are also discussed. A.

539.132 : 535.375.5

415. The vibrational frequencies of $CF_2{=}CH_2$. W. E. EDGELL AND W. E. BYRD. Letter in *J. Chem. Phys.*, **17**, 740–1 (*Aug.*, 1949).

Raman spectrum, assignment and results of normal co-ordinate treatment are given. D. H. WHIFFEN

539.133 : 537.226

The calculation of the polarisabilities, molecular radii and dipole moments of some organic liquids. *See Abstr.* 247

539.133 : 538.222

The energy levels of $Gd_2(SO_4)_3 \cdot 8H_2O$ in a magnetic field. *See Abstr.* 381

ATOMIC STRUCTURE . ISOTOPES 539.15

539.152.1

416. The binding energy of the triton. R. E. CLAPP. Letter in *Phys. Rev.*, **76**, 873–4 (*Sept.* 15, 1949).

An extensive calculation has been carried out using the Rarita and Schwinger square-well potential, and a set of orthogonal wave-functions involving up to 19 parameters. The results show that *D*-states not included by Gerjuoy and Schwinger [Abstr. 1605 (1942)] and others make an appreciable contribution to the binding. Up to 67% of the binding energy has been obtained in the calculations and 70% by extrapolating the results, as opposed to an estimated 50% using an *S* and one *D* state alone. G. J. KYNCH

539.152.1 : 539.172

Energy levels of nuclei. *See Abstr.* 478–80

539.152.2

417. On the sign of the electric quadrupole moment of Li^7. P. KUSCH. Letter in *Phys. Rev.*, **76**, 138–9 (*July* 1, 1949).

This has been found to be +ve, in disagreement with all proposed nuclear models, by the molecular beam magnetic resonance method. The magnitude is 2×10^{-26} cm^2. B. ROSE

539.152.2

418. Relation of nuclear quadrupole moment to nuclear shell structure. W. GORDY. Letter in *Phys. Rev.*, **76**, 139–40 (*July* 1, 1949).

Plots are given of Q against the atomic and the neutron number, showing a marked shell structure, with minima in Q at or near the magic numbers pointed out by Mayer [Abstr. 3861 (1948)]. Some of the Q values are estimated from measured values of the magnetic moment. B. ROSE

539.152.2

419. The magnetic moment of B^{11}. D. A. ANDERSON. Letter in *Phys. Rev.*, **76**, 434 (*Aug.* 1, 1949).

Value $2{\cdot}68939 \pm 0{\cdot}031\%$ nuclear magnetons assuming spin 3/2 from nuclear magnetic induction measurements on K metaborate solutions. Experimental details. D. H. WHIFFEN

539.152.2

420. The nuclear spin and magnetic moment of Cs^{137}. L. DAVIS, JR. Letter in *Phys. Rev.*, **76**, 435–6 (*Aug.* 1, 1949).

Values of 7/2 and $2{\cdot}837 \pm 0{\cdot}010$ nuclear magnetons respectively are found by the atomic beam magnetic resonance method. D. H. WHIFFEN

539.152.2

421. Computed binding energies of some light nuclei. J. S. SMART. Letter in *Phys. Rev.*, **76**, 439–40 (*Aug.* 1, 1949).

The binding energy function E_0 [Abstr. 2269 (1939)] has been recalculated based on the latest mass values. Indications of closed shells at $A = 20$ and 32 are obtained. Some corrections are given of errors in the above work. B. ROSE

539.152.2

422. The magnetic moments of Sn^{117}, Sn^{119}, and Pb^{207}. W. G. PROCTOR. Letter in *Phys. Rev.*, **76**, 684 (*Sept.* 1, 1949).

These were measured using a nuclear induction spectrometer, and agree with previous values of spin $= \frac{1}{2}$ for both Sn nuclei, magnetic moment $= -0{\cdot}89$ nuclear magneton; for Pb^{207}, spin $= \frac{1}{2}$, magnetic moment $= 0{\cdot}6$. Sn resonances were observed with a magnetic field 4 500 gauss. A comparison of recorded Sn signals with Na^{23} ones shows the sign of magnetic moment of both Sn nuclei is negative, of Pb^{207} positive; signal amplitudes are consistent with spin $\frac{1}{2}$ for all 3 nuclei. J. JACOBS

539.152.2

423. A precision measurement of the ratio of the nuclear g values of Li^7 and Li^6. P. KUSCH AND A. K. MANN. *Phys. Rev.*, **76**, 707–9 (*Sept.* 15, 1949).

The molecular beam magnetic resonance method has been used to make a precision measurement of the ratio of the nuclear g factors of Li^7 and Li^6. The central max. of the Li^7 line and the centre of the Li^6 line in the spectra of LiI and LiBr give the ratio g_7/g_6 to a precision limited only by experimental factors. The mean of 8 independent determinations, under various experimental conditions, is $2{\cdot}64094 \pm 0{\cdot}00005$. This value of the ratio is compared with that calculated by use of the Fermi formula from the known ratio $\Delta\nu_7/\Delta\nu_6$. The cube of the ratio of the reduced masses of the 2*s* electrons in Li^6 and Li^7 is included as a factor in the calculation by analogy with the corresponding case of the hydrogens. The observed value of g_7/g_6 is $>$ the value calculated by $(0{\cdot}012 \pm 0{\cdot}003)\%$. A.

539.152.2

424. Determination of nuclear gyromagnetic ratios. I. J. R. ZIMMERMAN AND D. WILLIAMS. *Phys. Rev.*, **76**, 350–7 (*Aug.* 1, 1949).

Nuclear magnetic resonance absorption peaks have been observed for 17 nuclear species. The technique used in observing the resonances involves the use of super-regenerative oscillators and is different in many respects from the bridge method of Purcell and the nuclear induction method of Bloch. Resonance absorption has been observed for the following nuclei: H^1, H^2, Li^7, Be^9, B^{11}, F^{19}, Na^{23}, Al^{27}, P^{31}, Cu^{63}, Cu^{65}, Br^{79}, Br^{81}, Rb^{85}, Rb^{87}, I^{127} and Cs^{133}. By comparison of various resonance peaks with the proton resonance peak observed simultaneously in the same magnetic field, values for nuclear gyromagnetic ratios and nuclear magnetic moments can be determined in terms of the gyromagnetic ratio and the magnetic moment of the proton. The following ratios of resonance frequency to proton frequency in same magnetic field have been obtained: H^2: 0·15355; Li^7: 0·38862; B^{11}: 0·32076; F^{19}: 0·94086; Na^{23}: 0·26454; Al^{27}: 0·26062; Cu^{63}: 0·26515; Cu^{65}: 0·28404; Br^{79}: 0·25059; Br^{81}: 0·27014; Rb^{87}: 0·32718; I^{127}: 0·20003. A.

539.152.2

425. Nuclear gyromagnetic ratios. II. W. H. CHAMBERS AND D. WILLIAMS. *Phys. Rev.*, **76**, 638–40 (*Sept.* 1, 1949).

By means of super-regenerative oscillator techniques, magnetic resonance absorption peaks have been observed for Be^9, P^{31}, Cl^{35}, Rb^{85}, Cs^{133} and La^{139}. By simultaneous observation of each of these resonances and of the proton absorption peak in the same magnetic field, the ratio of the resonance frequency ν of each of these nuclei to the proton

frequency ν_p in the same applied field has been determined. The values of ν/ν_p are as follows: Be^9: 0·14034 ± 0·00007; P^{31}: 0·40490 ± 0·00011; Cl^{35}: 0·09799 ± 0·00007; Rb^{85}: 0·09661 ± 0·00004; Cs^{133}: 0·13093 ± 0·00014; La^{139}: 0·14116 ± 0·00014. From these experimental results, the gyromagnetic ratio for each nucleus can be determined in terms of the gyromagnetic ratio of the proton provided suitable corrections for the diamagnetism of the electrons are applied. A.

539.152.2

426. Nuclear spin and magnetic moment of Cs^{135} and Cs^{137}. D. E. Nagle. Letter in *Phys. Rev.*, **76**, 847–8 (*Sept.* 15, 1949).

An atomic beam magnetic resonance apparatus was used with a mass spectrometric detector enabling resonance transitions to be observed for Cs^{135} in the presence of the 133 carrier, as well as the 137 transitions. The results indicate a hyperfine structure separation of 9 724 Mc/s and a nuclear magnetic moment of 2·721 nuclear magnetons for Cs^{135}. Earlier results for Cs^{137} are confirmed. G. F. HODSMAN

539.152.2

427. Nuclear magnetic resonance at low temperatures. J. Hatton and B. V. Rollin. *Proc. Roy. Soc. A*, **199**, 222–37 (*Oct.* 25, 1949).

Investigations have been made on nuclear paramagnetism at low temps. by the radio-frequency resonance absorption method. In measurements on solid H it has been found that there are considerable changes in the width of the resonance line with change of temp. These effects are related to changes in the nature of the molecular motions and the state of the molecular order. A number of experiments has been made on nuclear spin-lattice relaxation in different substances. It has been shown that in ionic crystals the nuclear relaxation is greatly affected by the presence of paramagnetic impurities. The nuclear relaxation time in metals has been found to be in reasonable agreement with theoretical predictions. Measurements have been extended to temps. below 1°K, and the possibility of cooling the nuclear spin system by adiabatic demagnetization has been verified. The results for nuclear spin-lattice relaxation are considered in relation to the possible applications of nuclear paramagnetism in the region of very low temps. A.

539.152.2 : 535.338.332

428. Nuclear spin of Fe^{57}. M. Gurevitch and J. G. Teasedale. Letter in *Phys. Rev.*, **76**, 151 (*July* 1, 1949).

Inspection of many lines in the region 4 000–6 800 Å in the spectrum of Fe enriched in Fe^{57} showed no HFS, indicating no measurable value for $\mu(Fe^{57})$. B. ROSE

539.152.2 : 535.343.4–14

429. The nuclear spin and quadrupole moment of I^{129}. R. Livingston, O. R. Gilliam and W. Gordy. Letter in *Phys. Rev.*, **76**, 149–50 (*July* 1, 1949).

From measurements of hyperfine structure in the rotational spectrum of CH_3I^{129}, in the 6·75 mm wave region, the spin was found to be 7/2. The ratio $Q(I^{129})/Q(I^{127}) = 0·7353$, whence $Q(I^{129}) = -0·34 \times 10^{-24}$ cm² or $-0·43 \times 10^{-24}$ cm², depending on which of two previous values of $Q(I^{127})$ is used [Abstr. 2133 (1940), 1816 (1949)]. B. ROSE

539.152.2 : 535.343.4–14

430. Nuclear magnetic moments from microwave spectra: I^{127} and I^{129}. W. Gordy, O. R. Gilliam and R. Livingston. Letter in *Phys. Rev.*, **76**, 443–4 (*Aug.* 1, 1949).

Approximate values from the partially resolved Zeeman splitting of $J_{2\to3}$ line in CH_3I are I^{127}: 2·810 ± 2·2%; I^{129}: 2·74 ± 5%. Advantages of the method and of the structure of the I^{129} nucleus are discussed. D. H. WHIFFEN

539.152.2 : 535.343.4–14

431. Nuclear spin and quadrupole moment of Cl^{36}. C. H. Townes and L. G. Aamodt. Letter in *Phys. Rev.*, **76**, 691–2 (*Sept.* 1, 1949).

These are found to be 2 and $-0·0172 \pm 0·0004$ 10^{-24} cm² respectively from the hyperfine structure of the $J = 1 \to 2$ rotational line of $Cl^{36}C^{12}N^{14}$. A Stark modulation instrument with phase detection amplifier was used. Position of strongest 3 lines and intensities in experimental spectrum agree most closely with those of a theoretical curve with spin 2 out of 3 theoretical spectra with spins 1, 2, 3. The N^{14} quadrupole coupling constant is allowed for in theoretical calculations, also the quadrupole moment and coupling constant of Cl^{35}, leading to the nuclear quadrupole moment of Cl^{36}. It is 0·25 of the average quadrupole moment of Cl^{35} and Cl^{37} as expected if 1 odd proton and neutron in *d* orbitals contribute to nuclear moment of Cl^{36} in $^3F_2$ state. J. JACOBS

539.152.2 : 535.343.4–14

432. Evidence on nuclear moments of stable Ge and Si isotopes from microwave spectra. C. H. Townes, J. M. Mays and B. P. Dailey. Letter in *Phys. Rev.*, **76**, 700 (*Sept.* 1, 1949).

The rotational line $J = 0 \to 1$ for GeH_3Cl was studied and hyperfine structure compared with theoretical curves as to position and intensity. Computed curves assumed quadrupole coupling constant of Ge^{73} as -95 ± 3 Mc/s, spins 3/2, 5/2, 7/2, 9/2, and show that only spin 9/2 is admissible. No quadrupole moments were observed for Ge^{70}, Ge^{72}, Ge^{74}, Ge^{76}; calculations show these should be $<1/30$ of Ge^{73} moment, i.e. $0·007^{-24} \times 10$ cm². This supports the view that spin of even Ge isotopes is zero which would lead to unobservable quadrupole moment. Si moments from SiH_3Cl spectrum are less clear; no hyperfine structure due to Si nuclei was observed. Thus spins for even Si isotopes Si^{28}, Si^{30} are zero, spin of Si^{29} is 1/2. J. JACOBS

539.152.2 : 535.343.4–14

433. Nuclear spin and quadrupole coupling of S^{35}. V. W. Cohen, W. S. Koski and T. Wentink, Jr. Letter in *Phys. Rev.*, **76**, 703–4 (*Sept.* 1, 1949).

The hyperfine and Stark structure of the rotational line $J = 1 \to 2$ of carbonyl sulphide containing S^{35} is recorded at 23 461 ± 5 Mc/s. From it the electric quadrupole coupling constant is estimated as $+20 \pm 4$ Mc/s. A comparison with theoretical curves using spin 3/2 or more admits only a nuclear spin of 3/2 for S^{35}. A Stark modulation spectroscope at 100 kc/s was used with a phase-sensitive detector. J. JACOBS

539.152.2 : 536.631 : 536.48

434. A possible nuclear effect in magnetic cooling experiments on copper salts. C. G. B. GARRETT. Letter in *Nature, Lond.*, **163**, 956 (*June* 18, 1949).

The effect of coupling between electronic and nuclear moments in Cu salts on the specific heat near 0·1°K is discussed. D. H. WHIFFEN

539.153 : 523.877

Self-consistent field with exchange for Ca XIII. *See Abstr.* 32

539.155 : 518.5

435. On an electrical analogy of the masses of isotopes and nuclear reaction energies. L. WALDMANN. *Z. Naturforsch.*, **4a**, 226–7 (*June*, 1949) *In German.*

An electrical network can be used directly to find nuclear masses from the simultaneous equations for them obtained when a method of least squares is applied to the energy balance equations of nuclear reactions. G. J. KYNCH

539.155.1

436. A new measurement of the Pt^{195}–Cu^{65} packing fraction difference. H. E. DUCKWORTH. Letter in *Phys. Rev.*, **76**, 690 (*Sept.* 1, 1949).

The packing fraction difference Pt^{195}–Cu^{65} was measured in a large new Dempster-type mass-spectrograph; the mean value was $(9{\cdot}26 \pm 0{\cdot}03) \times 10^{-4}$. In addition Pt^{194}–$\overline{Cu} = (8{\cdot}89 \pm 0{\cdot}10) \times 10^{-4}$; Pt^{196}–$\overline{Cu} = (9{\cdot}44 \pm 0{\cdot}20) \times 10^{-4}$, where $\overline{Cu}$ is the mean packing fraction for the Cu isotopes.

A. O. STANESBY

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16 : 541.133.1

A rapid electrical method of separating carrier-free radioactivities. *See Abstr.* 564

539.16 : 614.8

Disposal of radioactive wastes by biological methods. I. *See Abstr.* 636

539.16.08

437. Radioactivity measuring apparatus. A review of current techniques. D. TAYLOR. *Atomics*, **1**, 37–44, 55 (*Sept.*, 1949).

539.16.08

438. Preparation of silver bromide precipitates for radioactivity measurements. F. P. W. WINTERINGHAM. Letter in *Nature, Lond.*, **164**, 183–4 (*July* 30, 1949).

The precipitate is collected on a filter paper and bonded with Alkathene to form a hard flat disc for counting with an end window counter. 20 precipitates prepared in this way from a given solution showed an overall coeff. of variation of ±1·8% on counts of 10^4. This method of assay is 15× as efficient as using a liquid counter. B. ROSE

539.16.08

439. Determination of radiophosphorus in plant material by solution counting. C. MCAULIFFE. *Analyt. Chem.*, **21**, 1059–61 (*Sept.*, 1949).

539.16.08 : 771.53

440. The fogging of photographic film by radioactive contaminants in cardboard packaging materials. J. H. WEBB. *Phys. Rev.*, **76**, 375–80 (*Aug.* 1, 1949).

Following the detonation of the experimental atom bomb at Alamogordo, New Mexico, on July 16, 1945, a radioactive contaminant was encountered in strawboard material used by the Eastman Kodak Company for packaging photographic sensitive films. This paper board was manufactured in a mill situated at Vincennes, Indiana (about 1 000 miles from N.M.) A run of strawboard, produced on August 6, 1945, showed this new and unusual type of radioactive contaminant. X-ray film packed with this board showed fogged spots after about 2 weeks' exposure. Measurements of the contaminated spots of strawboard showed no α-activity but fairly strong β-activity. Absence of α-activity ruled out naturally radioactive materials. Measurements of the β-activity showed a max. energy of about 0·6 MeV and a ½-life of approx. 30 d. Radiochemical studies of the active ash from the strawboard indicated that the material was of the rare earth series. The energy value and ½-life of the β-radiation are compatible with the isotope, Ce 141. All studies point to the conclusion that the radioactive contaminant was an artificially radioactive material which found its way into the mill through the river water. The most likely explanation seems to be that it was a windborne fission product derived from the atom-bomb detonation. A.

539.162

441. Directional effects in radioactivity. J. A. SPIERS. *Nat. Res. Coun. Can. Publ.* (*No.* 1925) 90 *pp.* (1949).

Theoretical investigation of the effect on the angular intensity distribution ("polar diagram") of the radiation of a radioactive substance maintained at low temp. ($\lesssim 0{\cdot}01$°K) in a powerful magnetic field ($\sim 10^5$ gauss). A. O. STANESBY

539.163 : 538.69

442. On the influence of a homogeneous longitudinal magnetic field on the radiation emitted by a radioactive preparation. F. EHRENHAFT AND R. F. K. HERZOG. *C.R. Acad. Sci., Paris*, **228**, 550–1 (*Feb.* 14, 1949) *In French.*

A continuation of previous work [Abstr. 4104 (1949)]. A photographic plate under 2 mm Al absorber was clearly blackened in a 24 hr exposure to RaE with the magnetic field on, but in 135 hr with the field off was scarcely blackened at all. The range of the β-rays from RaE is ~ 1·8 mm. B. ROSE

539.163

443. On the separation of nuclear isomers. G. KAYAS. *C.R. Acad. Sci., Paris*, **228**, 1804–6 (*June* 8, 1949) *In French.*

The two isomers of Br^{80}, 18 min and 4·5 hr, have been separated from a sample showing a pure 4·5 hr activity, by a simple chemical procedure. B. ROSE

539.163 : 539.172.4

444. Mass assignment of the 43 minute Hg isomer. I. BERGSTRÖM AND S. THULIN. Letter in *Phys. Rev.*, **76**, 313 (*July* 15, 1949).

The activity is assigned to Hg^{199} by separation in

a mass-spectrograph of Hg previously irradiated with fast neutrons. By irradiation of separated Hg isotopes, it is suggested that the reactions $Hg^{199}(n, n)Hg^{199*}$ and $Hg^{200}(n, 2n)Hg^{199*}$ may occur.

B. ROSE

539.163

445. Long-lived tellurium isomers. R. D. HILL. *Phys. Rev.*, **76**, 333–5 (*Aug.* 1, 1949).

The internal conversion electron spectra of neutron-activated enriched Te isotopes have been studied. It has been shown that each odd mass-number isotope from 121 to 131 exists in a long-lived isomeric state. In all cases the initial isomeric transition is 2^4-pole magnetic, which appears to identify the long-lived isomeric states with a spin of 11/2. The spins of the ground states of Te^{127}, Te^{129}, Te^{131} would appear to be 3/2, and that of Te^{123} 1/2. Information about Te^{121} and Te^{125} ground states is incomplete.

A.

539.163

446. Decay scheme of Te^{125m}. J. C. BOWE AND G. SCHARFF-GOLDHABER. Letter in *Phys. Rev.*, **76**, 437–8 (*Aug.* 1, 1949).

Magnetic spectrometer study has revealed L and M conversion lines due to a 35·4 keV transition in addition to the known 109·3 keV radiation in 58-day isomer Te^{125}. The presence of unconverted 35·4 keV γ-rays was confirmed by the production of characteristic fluorescence in I. Photon-photon coincidence measurements yielded a value 0·6–0·8 for the fraction of 35·4 transitions converted in the K shell and 0·15–0·20 for the fraction unconverted. It is suggested that the 109·3 keV radiation precedes the lower energy transition, observations by the delayed coincidence technique indicating a $\frac{1}{2}$-life $< 5\times10^{-8}$ sec for the intermediate state. The conversion data indicates either electric or magnetic dipole radiation, the former being most likely on the basis of the lifetime measurement.

L. R. SHEPHERD

539.163

447. Radioactive tin 111. R. A. HINSHAW AND M. L. POOL. *Phys. Rev.*, **76**, 358–9 (*Aug.* 1, 1949).

A radioactive isotope of a $\frac{1}{2}$-life of $35·0 \pm 0·5$ m has been found in the Sn fraction of Cd bombarded with α-particles. Using electromagnetically enriched Cd the assignment can be made to Sn 111. Positrons of 1·45 MeV and X-rays are observed.

A.

539.163

448. Radioactive tin 121, 123, 125. J. C. LEE AND M. L. POOL. *Phys. Rev.*, **76**, 606–8 (*Sept.* 1, 1949).

The 130 d activity in Sn is now assigned to Sn^{123} and emits a 1·3 MeV β-particle. No γ-radiation is observed. A 40 min activity emitting γ-radiation and a 1·32 MeV β-particle has also been assigned to Sn^{123}. Assigned to Sn^{125} are a 10 d activity and a 9·8 min activity which emit a 2·1 MeV β-particle and a 1·3 MeV β-particle, respectively. The 1·1 d Sn^{121} which emits a negative particle of energy 0·35 MeV has been confirmed.

A.

539.163

449. Radioactivity of Mo^{91} and Mo^{93}. R. B. DUFFIELD AND J. D. KNIGHT. Letter in *Phys. Rev.*, **76**, 573–4 (*Aug.* 15, 1949).

15·5 min and 75 sec activities were obtained by irradiating Mo oxide with X-rays from a 23 MeV betatron. Both activities were assigned to Mo^{91} (produced by $Mo^{92}(\gamma n)$ reaction), as a result of tests with samples enriched in Mo^{92} and Mo^{94} and chemical separation to rule out the possibility of Cb activities. End-points of $3·7 \pm 0·1$ MeV and $2·6 \pm 0·2$ MeV were obtained respectively for the 15·5 min and 75 sec positron spectra, using Al absorbers and the Feather method. γ-radiation of 0·3 MeV was also present in the shorter period activity. No 6·7 hr Mo activity was produced by the betatron irradiation nor by pile neutron irradiation of enriched Mo^{92} or Mo^{94} samples.

L. R. SHEPHERD

539.163 : 539.172.4

450. Neutron induced radioactivities in V^{52}, Mo^{99} and W^{185}. J. M. CORK, H. B. KELLER AND A. E. STODDARD. Letter in *Phys. Rev.*, **76**, 575–6 (*Aug.* 15, 1949).

Values of $\frac{1}{2}$-life and energy are given for the various γ-emissions produced by slow neutron capture. Energies were obtained from conversion electrons and from Pb absorption.

A. P. FRENCH

539.163.1

451. On the half-life of Na^{22}. L. J. LASLETT. Letter in *Phys. Rev.*, **76**, 858 (*Sept.* 15, 1949).

The decay of a sample has been followed for 3 y, giving a $\frac{1}{2}$-life of 2·6 y.

B. ROSE

539.163.2

452. The disintegration energy of Al^{29}. L. SEIDLITZ, E. BLEULER AND D. J. TENDAM. Letter in *Phys. Rev.*, **76**, 861–2 (*Sept.* 15, 1949).

By absorption and coincidence techniques, the decay was found to be complex, a 2·5 MeV β- (70–80%) being followed by a $1·2 \pm 0·2$ MeV γ-ray and a 1·4 MeV β- by a 2·3 MeV γ-ray, the total energy of the disintegration being $3·75 \pm 0·25$ MeV. Curves are shown of the total decay energies of nuclei of the same isotopic spin, from N^{16} to Cl^{36}, and from N^{17} to S^{35}, in which Al^{28} and Al^{29} have anomalously high decay energies. This is interpreted as confirmatory evidence for the special stability of Si^{28} and Si^{29}, possibly due to a shell closure at $Z = 14$.

B. ROSE

539.164

453. U-234 specific alpha-activity. A. S. GOLDIN, G. B. KNIGHT, P. A. MACKLIN AND R. L. MACKLIN. *Phys. Rev.*, **76**, 336–9 (*Aug.* 1, 1949).

The specific α-activity of U-234 has been determined using pure samples grown from UX. The $\frac{1}{2}$-life period was found to be $2·67 \pm 0·04\times10^5$ yr. The corresponding abundance in natural U is $0·0000580 \pm 0·0000008$ by weight, in fair agreement with determinations by other methods.

A.

539.164 : 537.542

The measurements of α-particle energies with scintillation counters. *See Abstr.* 329

539.165

454. $\beta^+ - \beta^-$ decay of Br^{80}. B. S. DZHELEPOV, N. M. ANTON'EVA AND S. A. SHESTOPALOVA. *Dokl. Akad. Nauk, SSSR*, **64** (*No.* 3) 309–12 (1949) *In Russian.*

The spectrometer was of the semi-circular focusing type, the beam, however, being inclined at about 8° to the plane normal to the field. After one $\frac{1}{2}$-revolution the beam focuses in a counter, through

which it passes; it focuses again, after a further complete revolution, in a second counter below (i.e. taking the field as vertical) the first, coincidences between the 2 being measured. Graphs of the β^+ and β^- spectra are given and the following decay scheme proposed: 4·4 hr γ-decay, followed by K-capture (1·2%) or 1 MeV β^+ emission (1%) to Se^{80} or 2·2 MeV β^- emission (18 min, 97·8%) to Kr^{80}. The proportion of β^+ was determined experimentally. The proportion of K-captures was determined from Konopinski's formula [Abstr. 929 (1944)]. Confirmation of the scheme depends upon experimental determination of the K-capture probability and upon establishing that decay takes place to the ground states of Se^{80} and Kr^{80}. Calculation using Konopinski's formulae leads to $tf = 2{\cdot}5\times10^5$ for β^-, $tf = 2{\cdot}1\times10^5$ for β^+. These should be identical if decay is to the ground state and it is concluded that these values show that it is. J. C. E. JENNINGS

539.165

455. On selection rules in β-decay. B. S. Dzhelepov. *Dokl. Akad. Nauk, SSSR*, **65** (*No.* 2) 149–50 (1949) *In Russian.*

The author and A. V. Kudryavtseva have compiled tables giving tf values for 267 β-emitters [since published in *J. Exp. Theor. Phys., USSR*, **19**, 9, 761–83 (1949)]. Analysis leads to a new criterion of forbiddenness: a β-transition is allowed, if in the process no rearrangement of the nucleus takes place; it is always forbidden if a rearrangement does take place. In 260 cases this leads to the correct result, in 7 it is wrong. The criterion of no rearrangement is that the change of Coulomb energy together with the energy equivalent of $|n-p|$ should balance the β-energy. The author has shown [*Dokl. Akad. Nauk*, **62**, 51 (1948)] that no rearrangement occurs in β^+ transitions of the type $M_Z^{2Z-1} \rightarrow M_{Z-1}^{2Z-1}$; they are $\therefore$ allowed. All β^- transitions (except $H^3 \rightarrow He^6$) are forbidden since the Coulomb energy increases by $>$ the equivalent of $|n-p|$. Usually β^- spectra of the Fermi allowed shape have been taken to indicate allowed transitions, e.g. In^{114}, Cu^{64}; the author considered that forbidden spectra may obey the Fermi allowed formula and that these examples are forbidden, since $tf > 2\times10^4$, whilst for allowed $tf \simeq 3\,500$. Changes of angular momentum and of parity affect the degree of forbiddenness (e.g. K^{40}, Rb^{87} and Lu^{176}) but the energy criterion is primary. In 6 cases: He^6, B^{12}, Ru^{106}, Pd^{112}, In^{112} (all β^-) and C^{10} (β^+), $tf < 10^4$ although rearrangement energy is considerable. For various reasons the experimental data are suspect, except in B^{12}, for which the discrepancy is unexplained. In P^{30} (β^+) $tf = 1{\cdot}1\times10^5$ although rearrangement energy $\sim$ O; it is supposed that rearrangement must occur but that the associated energy change is small.

J. C. E. JENNINGS

539.165

456. Beta-ray spectra. H. J. Lipkin. Letter in *Phys. Rev.*, **76**, 567 (*Aug.* 15, 1949).

An unsuccessful attempt to explain the existence of allowed shape spectra in cases of forbidden β-decay. The decay is assumed to take place by the emission of electron and neutrino to an excited state of the residual nucleus, followed by the emission of a photon which is then absorbed by the electron. Calculations for $\Delta J = 1$ for the first transition and $\Delta J = 2$ for the second, using non-relativistic wave functions, gave a distribution which differs considerably from the observed spectra.

L. R. SHEPHERD

539.165

457. Beta decay of thulium 170. R. L. Graham and D. H. Tomlin. Letter in *Nature, Lond.*, **164**, 278–9 (*Aug.* 13, 1949).

Neutron irradiated thulium oxide was examined in a thick lens β-spectrometer and by absorption and coincidence techniques. The β-spectrum appeared to be simple with max. kinetic energy 970 $\pm$ 5 keV and K, L, M and N conversion lines due to a transition of 82·7 keV were observed. γ-radiation of this energy and the K X-rays of Yb were detected by means of spectrometer observations using Sn and Pb radiators and by the absorption technique. A 400–500 keV radiation of about 2% intensity, also revealed by these observations, was attributed to bremsstrahlung. A simple decay scheme is suggested with all β-transitions going to the 82·7 keV level in Yb^{170}. Values of 40% and 20% respectively were found for the K and L conversion coeffs. of the 82·7 keV transition. L. R. SHEPHERD

539.165

458. Beta-decay of In^{115*}. P. R. Bell, B. H. Ketelle and J. M. Cassidy. Letter in *Phys. Rev.*, **76**, 574 (*Aug.* 15, 1949).

The electron spectrum from In^{115*} was investigated with a magnetic lens spectrometer and an anthracene scintillation spectrometer. The pulse height/energy calibration of the latter was obtained from observations on the 630 keV conversion line of Cs^{137}. Both methods showed a conversion line due to a 338 keV γ-ray transition and a weak continuum. An end-point of 830 $\pm$ 20 keV was deduced for the latter with the lens spectrometer and an intensity of 0·13 relative to the conversion line. The conversion occurs in the transition to the ground state of In^{115} and the β-transition is assumed to go from the metastable In^{115*} to the Sn^{115} ground state.

L. R. SHEPHERD

539.165

459. Coincidence and absorption measurements on Cs^{134}, I^{124}, Au^{199}, and Ca^{45}. J. L. Meem, Jr. and F. Maienschein. *Phys. Rev.*, **76**, 328–32 (*Aug.* 1, 1949).

The β-ray spectrum of Cs^{134} was investigated by absorption and β-γ-coincidence measurements. β-rays of 0·60 MeV and about 90 keV were observed. In I^{124}, the max. energy of the β-rays was found to be 2·30 MeV and β-γ-coincidences showed the β-spectrum to be simple. A max. γ-ray energy of 2·24 MeV was observed with several lower energy γ-rays indicated. γ-γ-coincidences were found, but coincidences between β-particles and internal conversion electrons could not be detected. Au^{199} exhibited a β-ray of 0·32 MeV, and the β-γ-coincidence rate per β-ray was independent of absorber thickness. A max. γ-ray energy of about

0·21 MeV was found by coincidence absorption of photoelectrons and coincidences between β-particles and internal conversion electrons. γ-γ-coincidences were obtained. The 43 min isomeric state of Hg sometimes attributed to Hg^{199} was not observed to grow from Au^{199}. Ca^{45} was found to have a single β-ray of 0·22 MeV and no γ-rays. A.

539.165

460. The forbidden transition of yttrium^{91} and cesium^{137}. J. S. Osoba. *Phys. Rev.*, **76**, 345–9 (*Aug.* 1, 1949).

Y^{91} decays by the emission of a single β-particle with a max. energy of 1·54 MeV, while Cs^{137} decays in two ways, (1) β-decay (max. energy = 0·518 MeV) to Ba^{137*} followed by a γ-transition to the ground state, and (2) β-decay (max. energy = 1·2 MeV) directly to the ground state. Probably $< 5\%$ of the Cs^{137} nuclei decay directly to the ground state. Conventional (allowed transition) Kurie plots of Y^{91} and the low energy group of β-particles of Cs^{137} display curvature which is concave toward the energy axis at high energies and concave upward at low energies. If it is assumed that Gamow–Teller selection rules govern the β-process, the Fermi function $F(Z, W)$ for allowed spectra must be multiplied by a factor $G = (W^2 - 1) + (W_0 - W)^2$ in a β-transition for which there is a change of parity and for which the spin change is 2 units. If these conventional Kurie plots of Y^{91} and Cs^{137} are modified by the factor G, the resulting plots are approximately straight lines. This indicates that the β-decay of Y^{91} and the low energy β-decay of Cs^{137} involve a spin change of 2 units and a parity change. These results contribute evidence for the validity of the Fermi theory of β-decay and the Gamow–Teller selection rules. The K internal conversion coeff. for the 0·663 MeV γ from the decay of Cs^{137} was found to be 0·081, while the ratio of the K conversion electrons to the L conversion electrons was 5·0. The γ-radiation seems to be either magnetic 2^4-pole or electric 2^5-pole. A.

539.165

461. Radiations from indium (114) and barium (140). C. E. Mandeville and E. Shapiro. *Phys. Rev.*, **76**, 718–21 (*Sept.* 15, 1949).

In (114) emits soft conversion electrons (range ~ 20 mg/cm^2) and hard nuclear β-rays of energy 1·89 MeV. Pb absorption gives quantum energies of 0·15 MeV and 0·70 MeV whereas coincidence absorption yields a max. quantum energy of 0·90 MeV. The harder quanta are associated with an inner β-ray group constituting $< 1{\cdot}5\%$ of the total β-radiation, if with any group at all. A γ-γ-coincidence rate of $(0{\cdot}25 \pm 0{\cdot}02) \times 10^{-3}$ coincidence per γ-ray was noted. Ba (140) emits nuclear β-rays having a max. energy of 0·91 MeV and 2 γ-rays having quantum energies of 0·14 MeV and 0·6 MeV as indicated by absorption in Pb. β-γ-coincidence data, obtained from Ba^{140} in equilibrium with La^{140} and from Ba^{140} freshly separated from its daughter element, show that the β-ray spectrum is complex and that about 20% of the disintegrations proceed by way of the inner β-ray group which is coincident in time with γ-radiation. A.

539.165

462. K capture of Be^7 and the excited state of Li^7. R. M. Williamson and H. T. Richards. *Phys. Rev.*, **76**, 614–17 (*Sept.* 1, 1949).

The fraction of Be^7 K-capture to the 478 keV excited state of Li^7 has been experimentally determined to be $0{\cdot}107 \pm 0{\cdot}02$. The experimental method consisted in measuring the number of Be^7 atoms by counting neutrons from the $Li^7(p, n)Be^7$ reaction, and in observing the subsequent number of 478 keV γ-rays by use of a counter calibrated by β-γ-coincidences from Au^{198}. Implications concerning the character of the 478 keV Li^7 level are discussed. A.

539.165

463. Beta-spectra of forbidden transitions. L. M. Langer and H. C. Price, Jr. *Phys. Rev.*, **76**, 641–6 (*Sept.* 1, 1949).

The β-spectra of the forbidden transitions of Y^{91}, Sr^{89}, Y^{90}, Cs^{137}, RaE, Au^{198}, Re^{186} and P^{32} have been measured with thin sources and high resolution. Forbidden type spectra are found for the first 5. Au^{198}, Re^{186} and P^{32} yield spectra with the allowed shape. Evidence is advanced for the reliability of the nuclear shell structure model and for the validity of G.-T. selection rules. End points found are: Y^{91}, $1{\cdot}537 \pm 0{\cdot}007$ MeV; Sr^{89}, $1{\cdot}463 \pm 0{\cdot}005$ MeV; Y^{90}, $2{\cdot}180 \pm 0{\cdot}007$ MeV; Cs^{137}, $0{\cdot}51 \pm 0{\cdot}01$ MeV; Au^{198}, $0{\cdot}956 \pm 0{\cdot}005$ MeV; Re^{186}, $1{\cdot}063 \pm 0{\cdot}006$ MeV; and P^{32}, $1{\cdot}689 \pm 0{\cdot}01$ MeV. A.

539.165 : 615.849

A new beta-ray application using fission products. *See Abstr.* 639

539.165.2

464. Relation between half-life and disintegration energy in orbital electron capture by heavy nuclei. S. G. Thompson. Letter in *Phys. Rev.*, **76**, 319–20 (*July* 15, 1949).

The total energies of orbital electron capture of 15 heavy isotopes have been calculated from closed decay cycles and plotted logarithmically against the partial $\frac{1}{2}$-lives; a straight line goes through most of the points (except those of odd-odd nuclei), giving a provisional relation $\tau_{\frac{1}{2}} \propto E^{-4}$. A. O. Stanesby

539.166

465. On the continuous gamma-radiation accompanying the beta-decay of nuclei. C. S. W. Chang and D. L. Falkoff. *Phys. Rev.*, **76**, 365–71 (*Aug.* 1, 1949).

The quantum mechanical calculations of Knipp and Uhlenbeck and Bloch of the continuous γ-spectrum associated with the sudden change of nuclear charge during β-decay have been extended to forbidden β-transitions and to the different types of β-interactions. It is shown that the γ-spectrum has practically the same shape, and the ratio of total γ-intensity to β-intensity is almost the same for forbidden transitions as for allowed transitions, irrespective of the β-interaction. This accounts for the good agreement of the theory for allowed transitions with the experiments of Wu on $_{15}P^{32}$, a "forbidden" β-emitter. A simple classical analogue is given to explain this uniformity and is shown to justify the interpretation that the probabilities for

the β- and γ-emission processes may in a very good approximation be taken as independent. A.

539.166

466. Note on the resonance scattering of high energy γ-rays by nuclei of carbon and copper. E. R. Gaerttner and M. L. Yeater. *Phys. Rev.*, **76**, 363–4 (*Aug.* 1, 1949).

A search has been made for the resonance scattering of high energy γ-rays in nuclei of C and Cu using the 100 MeV betatron to provide the primary radiation. The scattering in C/Cu is $< 1\%$ and 3%, respectively, of the total cross-section for resonance absorption. A.

539.166

467. A revaluation of the gamma-radiations from Co^{60} and Zn^{65}. E. N. Jensen, L. J. Leslett and W. W. Pratt. Letter in *Phys. Rev.*, **76**, 430 (*Aug.* 1, 1949).

Revised values are given for the energies of γ-rays from Co^{60} and Zn^{65} previously reported by the authors [Abstr. 2692 (1949)] in the light of fresh data on the calibration of their magnetic lens spectrometer. Energies $1{\cdot}169$ MeV and $1{\cdot}331$ MeV are now assigned to the Co^{60} radiations and $1{\cdot}118$ MeV to that from Zn^{65}. L. R. SHEPHERD

539.166

468. Gamma-radiation from Na^{22} and Co^{60}. D. E. Alburger. Letter in *Phys. Rev.*, **76**, 435 (*Aug.* 1, 1949).

An Na^{22} source in a brass capsule was employed in conjunction with Pb, Th and U radiators and the secondary electron spectra examined in a magnetic lens spectrometer. Compton and K and L photoelectrons were observed from the $0{\cdot}5108$ MeV annihilation radiation (due to the positron decay) and from a γ-ray of $1{\cdot}277 \pm 0{\cdot}004$ MeV. As a check, the Co^{60} γ-rays were examined by the same method and energies $1{\cdot}175 \pm 0{\cdot}006$ MeV and $1{\cdot}332 \pm 0{\cdot}005$ MeV obtained, in good agreement with results of other experimenters. L. R. SHEPHERD

539.166

469. Absorption of 17·6 Mev gamma-rays in C, Al, Cu, Sn, and Pb. R. L. Walker. *Phys. Rev.*, **76**, 527–30 (*Aug.* 15, 1949).

The γ-ray absorption cross-sections of C, Al, Cu, Sn and Pb have been measured for the $17{\cdot}6$ MeV γ-rays produced in the $Li^7(p, \gamma)Be^8$ reaction. A γ-ray pair spectrometer was used as a detector in order to avoid counting lower energy quanta produced either in the $Li^7(p, \gamma)Be^8$ reaction, or as secondary radiation in the absorber. The measured cross-sections are compared to the sum of the theoretical cross-sections for Compton scattering, pair production in the field of the nucleus and pair production in the field of the atomic electrons. For the light elements, the agreement is within the experimental errors of about 1%, but for Pb the theoretical value is 10% $>$ the measured cross-section. This discrepancy probably results from the use of the Born approximation in the Bethe–Heitler calculation of pair production. The present results are in good agreement with recent measurements of Adams at $11{\cdot}04$, $13{\cdot}73$ and $19{\cdot}10$ MeV [Abstr. 2537 (1948)], and of Lawson at 88 MeV [Abstr. 2726 (1949)]. A.

539.166

470. Capture gamma-ray studies. H. E. Kubitschek and S. M. Dancoff. *Phys. Rev.*, **76**, 531–7 (*Aug.* 15, 1949).

Measurements are made of the max. energies of γ-rays emitted on neutron capture by a number of elements. Values so obtained are in rough agreement with semi-empirical formulae for neutron binding energies. Evidence is presented to show that γ-rays carrying nearly the max. energy are observed much more frequently than would be expected on statistical theories. The yield of γ-rays on neutron capture is studied and found to show a variation, on the elements examined, of $\pm$ 30% about a mean. A.

539.166

471. On the γ–γ angular correlation in Pd^{106}. D. S. Ling, Jr. and D. L. Falkoff. Letter in *Phys. Rev.*, **76**, 431 (*Aug.* 1, 1949).

An attempt to interpret this with a magnetic dipole-electric quadrupole mixture for the upper transition and pure quadrupole for the lower transition, did not lead to agreement with experiment. It is suggested that a higher multipole order must be involved in at least one of the transitions.

L. R. SHEPHERD

539.166

472. Absence of delayed γ–γ coincidences in the decay of hafnium 181. D. Walker and E. W. Fuller. Letter in *Nature, Lond.*, **164**, 226 (*Aug.* 6, 1949).

Delayed γ-γ-coincidences in sources of Hf^{181} which would result if the 20 μsec metastable state of Ta^{181} follows γ-emission have been reported by Benes *et al.* [Abstr. 3886 (1948)]. An attempt to observe these delayed coincidences is described, using as γ recorders two end-on Geiger counters with Pb radiators covering the windows. One counter gave a 38 μsec pulse at the coincident stage, the other a $0{\cdot}3$ μsec pulse and an anticoincidence circuit of 2 μsec resolving time was employed to suppress instantaneous coincidences. The Hf^{181} source was placed between the Pb radiators. It was found that $< 0{\cdot}7\%$ of the γ-rays recorded in the first counter could be followed by delayed γ radiation of 20 μsecs $\frac{1}{2}$-life, and hence $<$ 2–3% of the Hf^{181} disintegrations could follow the decay scheme suggested by Benes *et al.* L. R. SHEPHERD

539.166.74

473. Measurement of the energy $h\nu$ of a γ-radiation by the absorption of monokinetic Compton electrons. J. Jacquesson and A. Lataste. *C.R. Acad. Sci., Paris*, **229**, 38–40 (*July* 4, 1949) *In French.*

A barrel-shaped scatterer (Al of $0{\cdot}1$ mm thickness) was placed with its axis along the line joining γ-ray source to a β-counter, so that the Compton electrons received by the latter were all projected at the same angle with respect to the γ-rays. The angle of projection was chosen to be $\sim$ 20–30°, so as to give a reasonable yield of Compton electrons but very few pair electrons. The direct path from source to counter was blocked with Pb. Absorption curves for the Compton electrons were almost rectilinear when plotted semi-logarithmically. It is claimed that a γ-ray line spectrum can be rapidly analysed with $\sim 10\%$ accuracy by this method. A source strength of ~ 1 mc is required. A. P. FRENCH

539.166.831 : 537.531.85

474. Electrons ejected by polarized radiation. K. H. SPRING. Letter in *Proc. Phys. Soc., Lond. A*, **62**, 529–30 (*Aug.*, 1949).

On basis of momentum conservation and the Klein–Nishina distribution function for longitudinally scattered photons, and the assumption that to each scattered photon there corresponds only one recoil electron, the azimuthal distribution of the recoil electrons is found to be of the form $(1 - A\cos^2\chi)d\chi$. For high energies (low A) there is azimuthal symmetry for polarized radiation; in general, electron emission along H is 3 times that along E.

F. LLEWELLYN JONES

539.166.835

475. Corrections from radiation theory to pair production and bremsstrahlung. R. JOST AND J. M. LUTTINGER. *Helv. Phys. Acta*, **22** (*No.* 4) 391–2 (1949) *In German.*

e^2-corrections to effects calculated by perturbation theory can be determined for energetic particles. Other charged particles not present in initial or final states, but perhaps important in intermediate ones, do not alter e^2-corrections for effects without external field, if field present only through vacuum polarization.

J. JACOBS

539.166.835

476. Higher approximations to the Klein–Nishina formula from radiation theory. R. SCHAFROTH. *Helv. Phys. Acta*, **22** (*No.* 4) 392–4 (1949) *In German.*

e^6-corrections are determined using interaction representation. In addition a redefinition of fields is made so that a single free particle is independent of exchange effects with radiation field. Perturbation theory then gives e^6-terms in scattering cross-section for Compton-effect. Calculations have been carried out only for small energies so far. J. JACOBS

NUCLEAR REACTIONS 539.17

539.172

477. Preparation and use of tritium and deuterium targets. E. R. GRAVES, A. A. RODRIGUES, M. GOLDBLATT AND D. I. MEYER. *Rev. Sci. Instrum.*, **20**, 579–82 (*Aug.*, 1949).

Methods are described for preparing Ta–H and Zr–H targets for economic use of T. Ratios of H isotope to metals of about 1·0 were obtained. The use of these targets under d bomb. is discussed. A.

539.172 : 539.152.1

478. Energy levels of Si^{30}. J. E. BROLLEY, JR., M. B. SAMPSON AND A. C. G. MITCHELL. *Phys. Rev.*, **76**, 624–7 (*Sept.* 1, 1949).

The distribution in range of the protons arising when Al is bombarded by 22 MeV α-particles, produced in the cyclotron, has been investigated. 7 groups of protons, having energies up to 17 MeV, have been measured. The energy levels of the resulting Si^{30} nucleus have been calculated and are found to be 0·0, (2·28), 3·49, 7·18, 8·20, 9·26, 9·87 and 10·86 MeV. Inelastic scattering of protons from Al has also been measured. A.

539.172 : 539.152.1

479. The energy levels of the N^{14} nucleus. H. A. WILSON. Letter in *Phys. Rev.*, **76**, 687 (*Sept.* 1, 1949).

21 observed resonances are compared with predictions of the author's spherical shell model, showing good agreement. B. ROSE

539.172 : 539.152.1

480. Rotation levels of the Na^{24} and Ca^{41} nuclei. H. A. WILSON. Letter in *Phys. Rev.*, **76**, 687–8 (*Sept.* 1, 1949).

Neutron resonance levels in Na and Ca are interpreted in terms of the author's spherical shell nuclear model, showing fair agreement. Predictions are made concerning resonances in As^{76} and Bi^{210}. B. ROSE

539.172.1

481. Yields of manganese in spallation reactions. N. A. BONNER AND W. C. ORR. Letter in *Phys. Rev.*, **76**, 140–2 (*July* 1, 1949).

Curves are given showing the relative cross-sections for the production of Mn^{52} and Mn^{56} by the bombardment with 180 MeV deuterons of all elements from Cr to Sr, excluding Ru and Kr. B. ROSE

539.172.1

482. Energy release in beryllium and lithium reactions with protons. A. V. TOLLESTRUP, W. A. FOWLER AND C. C. LAURITSEN. Letter in *Phys. Rev.*, **76**, 428–30 (*Aug.* 1, 1949).

Reactions $Be^9 + H^1 \rightarrow Li^6 + He^4 + Q_1$; $Be^9 + H^1 \rightarrow Be^8 + D^2 + Q_2$ ($Be^8 \rightarrow 2He^4 + Q_2'$); $Li^6 + H^1 \rightarrow He^3 + He^4 + Q_3$ were studied by bombarding (*a*) thin Be foils with 603 keV protons, and (*b*) evaporated Li film (on Cu) with 742 and 1 237 keV protons. Recoil particles were studied at angles of 80° and 137·8°, with a double focusing magnetic spectrometer, using a ZnS scintillation counter and Al foil absorbers to distinguish between the various particles, Li^{6+++}, He^{4++}, D^{2+}, Li^{6++}, He^{4+}, He^{3++} and scattered protons. Energy calibration of the spectrometer was achieved by observations on the protons, elastically scattered from the target materials. A continuous distribution of α-particles from the Be^8 disintegration, was observed in accordance with theoretical expectations. The values obtained for the reaction energies were as follows: $Q_1 = 2{\cdot}12 \pm 0{\cdot}012$ MeV; $Q_2 = 0{\cdot}558 \pm 0{\cdot}003$ MeV; $Q_2' = 89 \pm 5$ keV; $Q_3 = 4{\cdot}017 \pm 0{\cdot}022$ MeV.

L. R. SHEPHERD

539.172.1

483. The neutrons from the disintegration of sodium by deuterons. C. E. MANDEVILLE. Letter in *Phys. Rev.*, **76**, 436–7 (*Aug.* 1, 1949).

On bombardment with 1·4 MeV deuterons, Na produced 7 neutron groups at 90° to the incident beam, detected by H recoil in photographic plates yielding 1 450 acceptable tracks. One additional group is assigned to $C^{12}(d, n)$. The groups indicate 6 levels of Mg^{24} at 0·83, 1·24, 1·66, 4·16, 7·70 and 8·64 MeV. The results are compared with levels indicated in other methods of production of Mg^{24}. In particular, the present results favour a disintegration scheme of Na^{24} in which the 2·76 precedes the 1·38 MeV γ-ray. B. ROSE

539.172.1

484. The neutrons emitted in the bombardment of ^{10}B and ^{11}B by deuterons. W. M. GIBSON. *Proc. Phys. Soc., Lond. A*, **62**, 586–91 (*Sept.*, 1949).

The photographic plate method has been used in an investigation of the neutrons from the (d, n) reactions in B^{10} and B^{11}, separated isotopes being used in the targets. The reaction $B^{10}(d, n)C^{11}$ gives neutron groups at 6·70 MeV and 4·85 MeV; these give an energy release for the transition to the ground state of 6·59 ± 0·10 MeV, and show the existence of a level in C^{11} at 2·02 ± 0·10 MeV. The reaction $B^{11}(d, n)C^{12}$ gives well-defined neutron groups at 13·51 MeV, 9·40 MeV and 4·55 MeV, with a continuous distribution up to 6 MeV and a small peak at 6·4 MeV. The 13·51 MeV group gives an energy release of 13·92 ± 0·15 MeV for the transition to the ground state; the other groups confirm the existence of levels in C^{12} at 4·47 ± 0·10 MeV, 9·72 ± 0·15 MeV and less certainly 7·7 MeV, while the continuous distribution is due to the reaction $B^{11}(d, n)3\alpha$. A.

539.172.1

485. High energy induced fission of bismuth and lead. R. H. GOECKERMANN AND I. PERLMAN. *Phys. Rev.*, **76**, 628–37 (*Sept.* 1, 1949).

A study has been made of the characteristics of the fission induced in Bi and Pb by irradiation with the high energy deuterons using radiochemical methods for the determination of yields of the fission products. The fission yield curve resulting from 190 MeV deuteron fission of Bi was found to be a single symmetrical peak with a max. fission yield of 5·0% at a mass number of approximately 100. The ratio of neutrons to protons was observed to be nearly constant for all nuclides formed in relatively good yield. The excitation function of the Mo^{99} yield in two Pb samples enriched, respectively, in Pb^{204} and Pb^{208} showed that the fission cross-section is larger and decreases less rapidly as the deuteron energy decreases in the Pb sample which has a higher proportion of the light isotopes. A mechanism has been postulated for the nuclear reaction which involves prior neutron evaporation from the initial highly excited nucleus followed by fission with unchanged charge distribution. A.

539.172.1 : 539.152.1

486. The excited state of Li^7 and the angular yield in $Li^6(d,p)Li^{7*}(\gamma)Li^7$. S. S. HANNA. Letter in *Phys. Rev.*, **76**, 686–7 (*Sept.* 1, 1949).

It is suggested that a measurement of the angular distribution of the γ-rays will provide definite information on the spin of the excited state. B. ROSE

539.172.1 : 539.185

487. Neutron-hydrogen mass difference from the $T^3(p, n)He^3$ reaction threshold. R. F. TASCHEK, H. V. ARGO, A. HEMMENDINGER AND G. A. JARVIS. *Phys. Rev.*, **76**, 325–7 (*Aug.* 1, 1949).

The threshold for the $T^3(p, n)He^3$ reaction has been carefully measured using protons from the Los Alamos electrostatic generator and a thick target of T absorbed in a Zr disc. The neutrons were observed at 0°, and the proton energy was measured relative to the accurately measured $Al^{27}(p,\gamma)Si^{28}$ resonance at 993.3 keV. The threshold for neutrons is found to be at a proton energy of 1 019 ± 1 keV, giving for this reaction $Q = -764 \pm 1$ keV. Assuming the rest mass of the neutrino to be zero, and the max. energy of the β-particle from the decay of T to be 18·5 keV, 782 ± 2 keV is obtained for the neutron-hydrogen mass difference. A.

539.172.1 : 539.163.2

488. Gamma radiation from deuteron bombardment of Be^9. V. K. RASMUSSEN, W. F. HORNYAK AND T. LAURITSEN. Letter in *Phys. Rev.*, **76**, 581–2 (*Aug.* 15, 1949).

The energies and intensities of 9 γ-rays produced by 1·2 MeV deuterons on a thick target were measured with a lens spectrograph. Lines at 413·5, 716·6, 1 021·6, 1 433, 2 152, 2 871 and 3 604 keV are ascribed to B^{10*}, at 472 keV to Li^{7*} and at 3 380 keV to Be^{10*}. The energies of 5 of the B^{10*} transitions, corrected for Doppler effect are $713n$, where $n = 1, 2, 3, 4, 5$, to an accuracy of 0·5%. B. ROSE

539.172.1 : 539.163.2

489. High energy gamma radiation from $Be^9 + D^2$. C. Y. CHAO, T. LAURITSEN AND V. K. RASMUSSEN. Letter in *Phys. Rev.*, **76**, 582–3 (*Aug.* 15, 1949).

3 high energy γ-rays at 3·97 ± 0·08, 4·47 ± 0·07 and 5·20 ± 0·1 MeV are reported, in addition to those mentioned in the preceding Abstr. Their total intensity is $< 2\%$ of the total γ-ray yield from $Be(d, n)B^{10}$ under the conditions used. The 5·20 MeV line is ascribed to B^{10}, since it agrees with a recently reported n-group from the same reaction [Abstr. 3443 (1949)]. B. ROSE

539.172.1 : 539.164

490. Angular distribution of α-particles from the $Li^7(p, \alpha)$ He^4 reaction. L. H. MARTIN, J. C. BOWER, D. N. F. DUNBAR AND F. HIRST. Letter in *Nature, Lond.*, **164**, 310 (*Aug.* 20, 1949).

This was studied using thin Li targets and proton energies from 130–960 keV for angles between 13°–167°, to the incident proton direction. Nuclear emulsion plates were employed for detection. The results were analysed on the basis of a yield distribution function $Y(\theta) = Y(90°)\,[1 + A(E)\cos^2\theta + B(E)\cos^4\theta]$ suggested by Heydenburg, Hudson, Inglis and Whitehead [Abstr. 3929 (1948)]. The variations of $A(E)$ and $B(E)$ with proton energy, were determined. The results in the region of 1 MeV were in reasonable agreement with those of Heydenburg *et al.* L. R. SHEPHERD

539.172.1 : 539.166

491. Gamma-radiation from light nuclei under proton bombardment. W. A. FOWLER AND C. C. LAURITSEN. Letter in *Phys. Rev.*, **76**, 314–15 (*July* 15, 1949).

Revises data given in an earlier review article [Abstr. 2190 (1948)] in the light of more recent work. B. ROSE

539.172.1 : 539.166

492. The angular distribution of γ-radiation from light nuclei. I. Experimental. S. DEVONS AND M. G. N. HINE. *Proc. Roy. Soc., A*, **199**, 56–73 (*Oct.* 7, 1949).

The experimental procedure used in studying the

angular distribution of γ-radiation produced by the proton bombardment of some light nuclei is described. Results are given for the radiation following proton capture by the nuclei Li^7, Be^9, C^{12}, C^{13} and for the radiation from the residual O^{16*} nucleus produced in the reaction $F^{19}(p, \alpha)O^{16*}$. Proton energies between 300 and 1 000 keV were available. The distribution of the radiation from Li^7 was investigated over the whole range of energies; in the other cases the distribution was measured at energies corresponding to resonance maxima for the processes. A.

539.172.1 : 539.166

493. The angular distribution of γ-radiation from light nuclei. II. Theoretical. S. DEVONS AND M. G. N. HINE. *Proc. Roy. Soc. A*, **199**, 73–88 (*Oct.* 7, 1949).

A general discussion is given of the factors which determine the angular correlation between incident particles and emitted radiation, in the case of particle capture by nuclei of light atoms. The results are applied to the cases $Be^9(p, \gamma)$; $C^{12}(p, \gamma)$; $C^{13}(p, \gamma)$; $F^{19}(p, \alpha)\, O^{16*}$, $O^{16*} \rightarrow O + \gamma$; and in some detail to $Li^7(p, \gamma)$. In the case of Li^7, the variation of the angular distribution of the γ-radiation with proton energy has been studied, and the results compared with a detailed theoretical interpretation, based on the Breit–Wigner dispersion formula applied to more than one level of the compound nucleus. The comparison provides excellent support for the validity of the dispersion formula, and the conditions are very favourable for such a check. A.

539.172.1 : 539.185

494. Angular distribution of neutrons from (*d*, *n*) reactions. C. E. FALK, E. CREUTZ AND F. SEITZ. Letter in *Phys. Rev.*, **76**, 322–3 (*July* 15, 1949).

The angular distribution of neutron fluxes resulting from bomb. of thick targets of various elements by a beam of 16 MeV deuterons has been measured with the help of threshold detectors. Target materials included $LiBO_2$, Be, B_4C, Co, Cu and Au, and detectors ranged from $Al^{27}(n, p)Mg^{27}$ with $\sim 4{\cdot}5$ MeV threshold to $C^{12}(n, 2n)C^{11}$ with 20·4 MeV threshold. It was found that the neutrons were emitted in narrow forward distributions with widths at $\frac{1}{2}$ maximum intensity, ranging from 26° to 49°, as measured in the laboratory system. L. R. SHEPHERD

539.172.13

495. An absolute calibration of the $Li^7(p, n)$ threshold voltage. W. E. SHOUPP, B. JENNINGS AND W. JONES. *Phys. Rev.*, **76**, 502–5 (*Aug.* 15, 1949).

Recent measurements of this threshold by electrostatic analyser methods have given a result about 2% > the older value made by an extrapolation of a resistor measurement of the $Li(p, \gamma)$ resonance at 440 kV. The $Li^7(p, n)$ threshold has now been measured by a third method, the r.f. ion speed gauge [Abstr. 303 (1949)]. The calibration by this method is absolute in that the kinetic energy of the particle is determined in terms of its known m/e and two easily measurable parameters, a length and a frequency. The results of this calibration place the threshold at (1·8812 ± 0·001) MeV in good agreement with values obtained from the electrostatic analyser measurements. A.

539.172.3

496. Thresholds for photo-neutron reactions in Mn, Zn, Zr, Mo, Cd, Pr, Nd, Au, Hg, Tl and Pb. A. O. HANSON, R. B. DUFFIELD, J. D. KNIGHT, B. C. DIVEN, AND H. PALEVSKY. Letter in *Phys. Rev.*, **76**, 578–9 (*Aug.* 15, 1949).

Extension of the work described in Abstr. 2725 (1949).

539.172.3

497. Remarks on the variation of (γ, *n*) cross-sections and the structure of light nuclei. R. CHASTEL. *C.R. Acad. Sci., Paris*, **228**, 1803–4 (*June* 8, 1949) *In French.*

It is suggested that it is easier to eject neutrons from nuclei which are not grouped into α-particles. This would account for the large increase of $\sigma(\gamma, n)$ above Ca [Abstr. 188 (1948)], beyond which stable nuclei of the form X_{2k}^{4k} do not exist. B. ROSE

539.172.3

498. Photo-disintegration of deuterium by seven- to twenty-Mev X-rays. E. G. FULLER. Letter in *Phys. Rev.*, **76**, 576–7 (*Aug.* 15, 1949).

A preliminary study of the distributions in angle and energy of the protons from the photo-disintegration of D by the continuous X-ray spectrum from 20·8 MeV electrons. At the higher energies (E) of the incident quanta, the cross-section was approx. $\propto E^{-\frac{1}{2}}$ and there was possibly a forward asymmetry in the ang. dist. A. O. STANESBY

539.172.3

499. A lower limit for the binding energy of the deuteron. G. R. BISHOP, C. H. COLLIE, H. HALBAN AND R. WILSON. Letter in *Phys. Rev.*, **76**, 683–4 (*Sept.* 1, 1949).

By comparison of the photo-neutrons and of the photo-protons produced in deuterium by Ga^{72} (γ-ray energies 2·21 and 2·51 MeV) and by RdTh (2·62 MeV), it is concluded that the binding energy of the deuteron $\geqslant 2{\cdot}207$ MeV. B. ROSE

539.172.3

500. Photoelectric disintegration of the deuteron. J. S. LEVINGER. Letter in *Phys. Rev.*, **76**, 699–700 (*Sept.* 1, 1949). The cross-section is found for a central Yukawa potential of range $(1/\mu) = 1{\cdot}18 \,.\, 10^{-13}$ cm chosen to give no force in states of odd L. A good approx. wave-function was used for the ground state ($L = 0$). The results are given for the range 6–100 MeV in the incident photon energy. G. J. KYNCH

539.172.3

501. The angular distribution of the photo-neutrons from beryllium. B. HAMERMESH, M. HAMERMESH AND A. WATTENBERG. *Phys. Rev.*, **76**, 611–13 (*Sept.* 1, 1949).

The angular distribution of the photo-neutrons from Be has been studied for γ-ray energies of 1·70, 1·81 and 2·76 MeV. The distribution was found to be spherically symmetrical for the 1·70 and 1·81 MeV γ-rays. The 2·76 MeV γ-ray yields a distribution of the form $a + b \sin^2 \theta$ with $a/b = 1{\cdot}2$. A.

539.172.3 : 537.531.9

502. Recent nuclear experiments with high voltage X-rays. W. Bosley and J. D. Craggs. *Rep. Phys. Soc. Progr. Phys.*, **12**, 82–101 (1948–49).

A review paper dealing with experimental work carried out, with some few exceptions, in the post-war years. Sections deal with experimental techniques (ionization chambers, Geiger counters and photo-multipliers), the use of Wilson chambers with the new particle accelerators (betatrons and synchrotrons, etc.), photo-fission, nuclear photo-effect, (γ-p) reactions, energy losses, etc., of high energy electrons and positrons and, in a preliminary manner, with the spectrum of the radiation from betatrons. A selection of typical Wilson chamber photographs is included.

J. D. CRAGGS

539.172.4

503. Neutron-capture cross section of 85-minute Ba^{139}. L. Yaffe, B. W. Sargent, M. Kirsch, S. Standil and J. M. Grunlund. *Phys. Rev.*, **76**, 617–20 (*Sept.* 1, 1949).

4 samples of barium carbonate were irradiated with neutrons at 3 different times and at 3 different positions in the heavy water pile. A few days after an irradiation, La separations were made until no further La^{140} activity could be detected. The La was discarded. At intervals of 4 to 9 d the La^{140} grown from the Ba^{140} was separated and its number of atoms determined with a calibrated G.M. counter. The fluxes of thermal neutrons were obtained by experiment as far as possible; the max. used was $2{\cdot}0 \times 10^{13}$ neutrons/cm^2/sec. The final value for the capture cross-section of Ba^{139} is $4{\cdot}7 \pm 1{\cdot}2$ barns. A.

539.172.4

504. Tracks in various materials of uranium fission fragments. F. Suzor. *Ann. Phys., Paris* (*Sér.* 12) **4**, 269–309 (*May–June*, 1949) *In French.*

The ranges of certain fission fragments from thin films of U deposited on Cu and Ni were determined by covering the films with many layers of thin foil of Al and other materials. Following n irradiation, the activity of 3 fission products, Zr^{97}, Te^{132} and Mo^{99} deposited in each layer, was measured to determine the range of these fragments. The spread in range of any one of these products was found to be $>$ predicted by Bohr's theory, and in contradiction to the theory, the spread was found to be greater for a light element (Al) than for a heavy one (Au). The range of Zr^{97} fragments was found to be slightly less for fast neutron irradiation (U^{238} fission) than for thermal neutrons (U^{235} fission). The relative stopping powers of Al, Au, Ag, Cu and cellulose acetate were determined for Zr^{97}. The atomic stopping power was roughly $\propto \sqrt{A}$, as for α-particles. Relative yields of Zr^{97}, Mo^{99} and Te^{132}, and the β end-points of these isotopes and their descendants, were determined. L. R. SHEPHERD

539.172.4

505. The thermal neutron absorption cross section of K^{39}. J. L. Hansen and J. E. Willard. Letter in *Phys. Rev.*, **76**, 577–8 (*Aug.* 15, 1949).

Samples of KCl were exposed to very intense irradiation (up to a max. of $\sim 8{\cdot}10^{19}$ neutrons/cm^2) and the K^{40} activity was counted after removal from the KCl of Cl^{36}, S^{35} and P^{32} activities. An increase of K^{40} activity by a factor ~ 3 relative to unexposed KCl was obtained with the strongest irradiation, giving a capture cross-section of $3{\cdot}1 \pm 1{\cdot}5$ barns for pile neutrons. A. P. FRENCH

539.172.4

506. A note on the $^{10}B(n, \alpha)^7Li$ reaction. S. Devons. *Proc. Phys. Soc., Lond. A*, **62**, 580–6 (*Sept.*, 1949).

It is difficult to explain the observed preponderance of transitions to the excited state of Li^7 in the reaction $B^{10}(n, \alpha)Li^7$ in terms of the usual assumption that the ground state and first excited state of Li^7 form a $^2P_{3/2,\,1/2}$ doublet. In addition the doublet separation (0·48 MeV) would be $\gg$ expected theoretically. If the excited state of Li^7 has total angular momentum other than 1/2, one would expect to find, in general, some angular correlation between the direction of emission of the α-particle, that of the subsequent γ-radiation and the polarization of the radiation. The correlations to be expected have been calculated on the assumption that the ground state of Li^7 is (3/2, odd), that of B^{10} (3, odd), or (3, even), and that the compound nucleus B^{11} has definite $J = 5/2$ or 7/2. Results are given for excited states of Li^7 with total angular momentum 1/2, 3/2, 5/2 and 7/2 and both even and odd parities. A.

539.172.4

507. The effect of holes in a reacting material on the passage of neutrons. D. J. Behrens. *Proc. Phys. Soc., Lond. A*, **62**, 607–16 (*Oct.*, 1949).

The increase in the migration length of neutrons in a reactor caused by the presence of holes in the reactor is discussed. It is shown how this effect can be evaluated in terms of a simple geometric function of the shape of the holes, and it is found that, in addition to a variation as the inverse overall density of the material in the reactor, the migration length also contains a term which depends upon the size and shape of each hole. When the hydraulic radius of the hole becomes comparable to the mean free path of neutrons in the reactor material, this last term becomes dominant, and it is therefore desirable that all holes should be kept as small as possible. Holes which are totally enclosed, or which contain a uni-directional infinity (cylinders) all give results of the same order of magnitude, but anything in the nature of a two-dimensional plane gash leads to a theoretically infinite increase in the migration length, and hence to a serious escape of spare neutrons. The cases both of holes of regular shape and of the interstices between a random arrangement of regular-shaped solid bodies are considered. A.

539.172.4 : 539.155.1

508. Ionization measurement of $He^3(n, p)$ and $N^{14}(n, p)$ and the neutron-hydrogen mass difference. W. Franzen, J. Halpern and W. E. Stephens. Letter in *Phys. Rev.*, **76**, 317–18 (*July* 15, 1949).

The energy releases, measured in an A-filled ion chamber containing a small amount of N and He enriched in He^3, were 764 ± 10 keV and 628 ± 4 keV resp., in good agreement with previous work on the inverse (p, n) reactions and the β end-points of C^{14} and H^3. These lead to n–H $= 783 \pm 4$ keV, which is $<$ the recent value of 804 ± 5 keV [Abtsr. 4957 (1949)]. B. ROSE

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

509. The production of mesons by photons and electrons. H. Feshbach and M. Lax. *Phys. Rev.*, **76**, 134–5 (*July* 1, 1949).

539.18

510. The absorption of negative π-mesons by protons. R. E. Marshak and A. S. Wightman. *Phys. Rev.*, **76**, 114–17 (*July* 1, 1949).

The lifetime for absorption of a π^--meson by a proton leading to the emission of a high energy photon has been calculated. Calculations have been performed for both scalar and pseudoscalar π^--mesons and for absorption "on the fly" and from bound states. The lifetimes from bound states are extremely short compared to the time for decay into μ^--mesons. The competition between π^0-emission and γ-emission is considered. Inverse processes are also discussed. A.

539.18

511. Spontaneous decay rate of heavy mesons. L. I. Schiff. Letter in *Phys. Rev.*, **76**, 303–4 (*July*, 1949).

Theoretical conclusions concerning the decay of π-mesons into electrons or μ-mesons, and the β decay of μ-mesons are discussed on the scalar theory and compared with the available experimental evidence.

E. P. GEORGE

539.18

512. Production of π-mesons by high energy nucleons. E. Strick and D. ter Haar. Letter in *Phys. Rev.*, **76**, 304 (*July* 15, 1949).

The discrepancy between the result of Urban and Schwartzl for this process [Abstr. 3467 (1949)] and that of Wang, is due to the neglect by the former of terms arising from the momentum of the virtual meson. Wang's result is therefore correct. The final result is not altered by allowance for recoil in these 3rd-order perturbation calculations.

G. J. KYNCH

539.18

513. Polarization of mesons produced at threshold in gamma-nucleons collisions. D. B. Feer. Letter in *Phys. Rev.*, **76**, 306 (*July* 15, 1949).

It is possible to produce near the threshold energy a beam of polarized integral-spin mesons by the synchrotron γ-ray beam. At threshold the ratio (long./trans.) production is, for v (vector) mesons, 0 (v coupling) and 0·4 (t coupling). For *ps-v* mesons it is ∞ (*ps-v* coupling) or 0 (*ps-t* coupling). The neglect of terms of order $(m/M)^2$ includes the variation with the meson kinetic energy up to 20 MeV. [See Abstr. 5245 (1949)]. G. J. KYNCH

539.18

514. Note on meson production. H. W. Lewis. Letter in *Phys. Rev.*, **76**, 566 (*Aug.* 15, 1949).

Re-writes formulae for multiplicity and angular spread of mesons, given in an earlier paper [Abstr. 1152 (1948)], so that they apply more justifiably to the energy region $5–15 \times 10^9$ eV. E. P. GEORGE

539.18

515. The time distribution of decay electrons from mesons stopped in magnesium at 3 500 meter altitude. A. H. Benade and R. D. Sard. *Phys. Rev.*, **76**, 488–95 (*Aug.* 15, 1949).

The time distribution of decay electrons from the natural mixture of positive and negative mesons stopped in 13·2 g/cm² Mg has been measured. The apparatus recorded delayed coincidences in 10 contiguous 0·6 μsec channels covering delays from 0·5 to 6·5 μsec. The time distribution of false delayed coincidences due to G.M. tube lags was also measured. These lags are shown to affect only the data from the first delay channel (0·5 to 1·1 μsec), and an approximate correction for this effect can be made. Corrections for accidental delayed coincidences are also applied. The results (based on 2 869 delayed coincidences) lie on a smooth differential decay curve, closely fitting the composite decay curve calculated on the assumption of competition between capture and decay for negative mesons. The effective mean life of the negative mesons is definitely $< 2{\cdot}15$ μsec, and appears to be approx. 1 μsec. The results can also be fitted by a single exponential of mean life $1{\cdot}7 \pm 0{\cdot}1$ μsec. A.

539.18

516. On the spin of μ-mesons. J. Tiomno. Letter in *Phys. Rev.*, **76**, 856 (*Sept.* 15, 1949).

Theoretical results are given to show that the experimental results on the decay of μ-mesons, $\mu \rightarrow \mu_0 + e + \nu$, are satisfactorily explained on the assumption that μ and μ_0 have the same spin value 0. When a μ-meson is captured by a nucleus, the nuclear excitation $P + \mu \rightarrow N + \mu_0$ is very similar for both spin 0 and spin $\frac{1}{2}$, and the probability of star production is small for spin 0. G. J. KYNCH

539.18

517. Decay of a heavy τ-meson into three lighter mesons. S. Power. Letter in *Phys. Rev.*, **76**, 865–6 (*Sept.* 15, 1949).

Assuming the τ-meson to be a pseudo-scalar particle, the theoretical lifetimes for decay into 3 π-mesons, or 1 π- and 2 μ-mesons, are given. The lifetimes of competing processes are discussed.

E. P. GEORGE

539.18

518. The production of mesons by electrons. I. N. Sneddon and B. F. Touschek. *Proc. Roy. Soc. A*, **199**, 352–61 (*Nov.* 7, 1949).

The cross-section of the production of mesons in collisions between electrons and nuclei is calculated. It is assumed that the electrons interact with the nucleons through the electromagnetic field. The results are given for the case of pseudoscalar mesons. It is found that for electrons of energy 300 MeV the cross-section is 2×10^{-30} cm² per nucleon. A.

539.18

519. On the decay of τ-mesons. C. B. van Wyk. *Proc. Phys. Soc., Lond. A*, **62**, 697–709 (*Nov.*, 1949).

The production of τ-mesons (mass about 900 electron masses) by cosmic rays in rather thin layers of air in the upper atmosphere seems to indicate that the nucleon τ-meson coupling constant is not very

small. The Berkeley experiments show that this is also true for the nucleon–π-meson coupling constant. Consequently the decay of a charged τ-meson into a photon and a charged π-meson by means of virtual creation and annihilation of nucleons ought to be fairly probable. In this paper this decay process, with the emission of one photon, is studied for the various types of τ- and π-mesons. Unless both mesons have zero spin, the matrix elements, and therefore the lifetimes, are found to be of the same order of magnitude, and the τ-meson turns out to be too short-lived to be observed photographically. If both mesons have zero spin the emission of only one photon is forbidden. A.

539.18 : 530.145

Exchange of charge between elementary particles. *See Abstr.* 55

539.18 : 530.145.6

Theory of particles of spin 2. *See Abstr.* 62

539.18 : 537.591

The meson intensity at the surface of the earth and the temperature at the production level. *See Abstr.* 346

539.18 : 539.166

520. Single production of mesons by gamma-rays near threshold. L. L. FOLDY. *Phys. Rev.*, **76**, 372–4 (*Aug.* 1, 1949).

The cross-section for single charged meson production through absorption of a γ-ray in a γ-ray-nucleon collision has been calculated to order e^2g^2 in the charged scalar meson theory (scalar coupling) and charged pseudoscalar meson theory (pseudovector coupling). The nucleon was assumed to be infinitely heavy, thus restricting the validity of the results to γ-ray energies $<$ a few times threshold. For a free nucleon the threshold for π-meson production is at 155 MeV in the rest system of the nucleon. Close to threshold, in the scalar theory the cross-section varies as the 3/2 power of the energy above threshold and the angular distribution is of the form $\sin^2\theta$, while in the pseudoscalar theory the cross-section varies as the square root of the energy above threshold and the angular distribution of the mesons is approximately isotropic. At energies 50% above threshold, the total cross-section is of order 10^{-28} cm^2 in the pseudoscalar theory and of order 10^{-29} cm^2 in the scalar theory. A.

539.18 : 778.3

521. On the measurement of the mass of charged particles by grain counts in sensitive emulsions. L. VAN ROSSUM. *C.R. Acad. Sci., Paris*, **228**, 676–8 (*Feb.* 21, 1949) *In French.*

The masses of negative π-mesons have been determined by magnetic deflection and in 14 cases of 17 mass values between 275–295 m_e have been found. 16 cases are compatible with the existence of a unique mass, but the interpretation in one case showing a mass 350 m_e was difficult. In order to compare the magnetic mass determination with that obtainable by grain counts in nuclear track plates, the residual ranges of the meson tracks have been measured in the emulsion. The result obtained by grain counts is given as $m_\pi = (280 \pm 15)\, m_e$. R. H. HERZ

539.185

522. Electrostatic scattering of neutrons. S. M. DANCOFF AND S. D. DRELL. *Phys. Rev.*, **76**, 205–12 (*July* 15, 1949).

A weak force of attraction between electrons and thermal neutrons is indicated in recent experiments by Havens, Rabi, and Rainwater, and by Fermi and Marshall [Abstr. 3675 (1947), 1075 (1948)]. According to meson theory this would be expected, since the neutron is considered as one charge state of a nucleon (the proton is the other state) which is coupled to a meson field. The attraction is then interpreted as an electrostatic scattering of the neutron which exists part of the time as a proton and meson. A third-order perturbation calculation is performed in the approximation of weak coupling between mesons and nucleons. Neutrons and protons are here treated as Dirac particles which are coupled to a meson field of spin zero. The results indicate that the observed interaction is suitably described in terms of the meson field. A.

539.185

523. Experimental corroboration of the theory of neutron resonance scattering. R. K. ADAIR, C. K. BOCKELMAN AND R. E. PETERSON. Letter in *Phys. Rev.*, **76**, 308 (*July* 15, 1949).

The total cross-section of S for neutrons in the range 16–250 keV has been determined from transmission measurements, using monoenergetic Li(p, n) neutrons. The total cross-section is accounted for almost entirely by elastic scattering. A sharp resonance peak was found at 111 keV with a natural width of 18 keV and a height $21{\cdot}5 \pm 1$ barn. A dip in the cross-section on the low energy side of the resonance is presumably caused by destructive interference between resonance and potential scattering. The results are in excellent agreement with an expression given by Feshbach, Peaslee and Weisskopf [Abstr. 1263 (1947)] for S-neutrons interacting with a nucleus of spin zero. The low cross-section of S for 1 eV neutrons is accounted for by the interference effect of the resonance. There is evidence of a much smaller resonance at 205 keV. L. R. SHEPHERD

539.185

524. Interaction of 14-Mev neutrons with deuterons. J. H. COON AND R. F. TASCHEK. *Phys. Rev.*, **76**, 710–15 (*Sept.* 15, 1949).

By coincidence counting of recoil deuterons in a proportional counter telescope the angular distribution for n–d scattering has been measured using monoergic neutrons of 14 MeV energy. The measurements covered the angular range corresponding to neutrons being scattered at angles between 180° and 70° in the centre of mass system, and by extrapolation an approximate curve was obtained over all angles. Upper limits can be placed on the probability of the n-$2n$ disintegration process for ejection of protons in the angular range from 0° to 120° in the centre of mass system. A.

539.185 : 517.948.3

525. Note on the variational method for finding extrapolated endpoints. H. HURWITZ, JR. Letter in *Phys. Rev.*, **76**, 867–8 (*Sept.* 15, 1949).

See Abstr. 2254 (1947).

539.185 : 537.133

526. Polarization effects in $n-p$ and $p-p$ scattering. L. WOLFENSTEIN. *Phys. Rev.*, **76**, 541–2 (*Aug.* 15, 1949).

Calculations have been made of the left-right asymmetry to be expected in n–p scattering if polarized neutrons are used. The detection of such an asymmetry would be direct evidence of a tensor force interaction in the scattering. A 4% asymmetry might be expected at 100 MeV using a (p, n) exchange reaction as a source of 20% polarized neutrons. Effects are smaller in p–p scattering. A.

539.185 : 537.591 : 778.3

527. Spontaneous neutron emission from uranium and samarium. H. YAGODA AND N. KAPLAN. Letter in *Phys. Rev.*, **76**, 702–3 (*Sept.* 1, 1949).

Nuclear emulsions loaded with high concentrations of B^{10} and Li^6 provide a sensitive recording medium for the measurement of slow neutron flux, because of the relatively large cross-section for slow neutron capture. A nuclear plate placed 1·3 cm from a 4 millicurie Po–Be source, both enclosed in a paraffin cylinder, recorded $8{\cdot}38 \times 10^3$ tracks per ml of emulsion originating from $B^{10}(n, \alpha)Li^7$ reaction after 15 min. exposure. The source emitted a total of $3{\cdot}85 \times 10^6$ fast neutrons during the same interval counted from proton recoil tracks, indicating a yield of one $(B^{10} + n)$ track per ml emulsion per 460 ± 24 fast neutrons generated. The yields of these reactions, using U, Sm_2O_3 powder and neutrons from cosmic rays as sources have also been determined. The average cosmic-ray slow neutron flux at sea level was found to be 20·1 cm^{-2}/day. The number of induced fissions in 36·4 g U is estimated to be 3·7 per day. Further calculations deal with the neutron yield from Sm α-particles interaction with Be^9. R. H. HERZ

539.185 : 778.3

528. Absolute measurement of neutrons in an atomic pile by the photographic method. P. CÜER, M. MORAND, T. KING AND R. LOCQUENEUX. *C.R. Acad. Sci., Paris*, **228**, 557–9 (*Feb.* 14, 1949) *In French.*

The neutron flux in the thermal column of a pile has been measured by observation of proton tracks in a photographic emulsion due to the reaction $N^{14}(n, p)C^{14}$. Errors arise from the presence of α + Li tracks due to B contained in the emulsion and from uncertainty as to N concentration, thickness of emulsion and correct cross-section for the $N^{14}(n, p)$ reaction. An accuracy $\sim 5\%$ is claimed possible in the measurement of neutron flux by this method. L. R. SHEPHERD

STRUCTURE OF SOLIDS 539.2

539.211

529. The mode of fracture at the neck of a tensile specimen. W. I. PUMPHREY. *Proc. Phys. Soc., Lond. B*, **62**, 647–51 (*Oct.*, 1949).

539.214

530. Thermodynamics of crystallization in high polymers. VI. Incipient crystallization in stretched vulcanized rubber. T. G. FOX, JR., P. J. FLORY AND R. E. MARSHALL. *J. Chem. Phys.*, **17**, 704–6 (*Aug.*, 1949).

Experimental determination of the elongation at which crystallization commences in vulcanized rubbe has been attempted through measurement of densit changes by a hydrostatic method. The critical elonga tion for incipient crystallization appears to depend o the temperature in approximate accordance wit theoretical prediction. Crystallization sets in at a elongation well below that at which the stress-strai curve assumes a steep slope.

539.215.

531. The morphology of carbon black particles i shadow-cast specimens. J. H. L. WATSON. *J. Appl Phys.*, **20**, 747–54 (*Aug.*, 1949).

Observations are given which favour a reticulat chain structure for carbon black. The discovery c "hollow" particles in carbon black dispersions c P-33 and Thermax is reported along with possibl explanations for the observed image intensities which give rise to the interpretation of hollowness Striated surfaces strongly suggestive of a lamina structure and serrated edges which conform i orientation with these plateaux have been detected Rough areas arranged both in lines and at random are observed over the surfaces of some particles Shape variations away from the spheroidal and th occurrence of straight-edged images are stressed again A.

539.23 : 541.127.

532. Theory of the oxidation of metals. N CABRERA AND N. F. MOTT. *Rep. Phys. Soc. Prog Phys.*, **12**, 163–84 (1948–49).

The phenomena involved can be classified into categories: the formation of stable films at lov temps. (logarithmic law of growth), the region o intermediate temps. (linear or cubic laws of growth) and the formation of thick films at high temps (parabolic law). Theoretical treatments of the various cases are given. The relative dimensions o the substrate and oxide lattices determine the mechanical compression of the film. This film shows much higher compressive strength than bulk materials. As the oxide film becomes thicker, i must break away to achieve its equilibrium lattice parameters. It can do so by the mechanisms of slip or re-crystallization. The latter process involves a prolonged induction period during which nuclei are formed. The process of oxidation is initiated by the strong electric field at the metal surface due to an adsorbed O film. This field enables metal ions to move even at low temps. and thus leads to further oxide formation. The phenomena depend greatly on the solubility of O and excess metal in the oxides formed. The cases of Al (whose oxide forms an excess semi-conductor) and Cu (whose oxide is a deficit semi-conductor) are treated in greater detail, with special reference to very thin oxide films. H. K. HENISCH

539.26

533. Sample scanning mechanism for X-ray diffraction. J. W. HICKMAN AND A. G. KLEINKNECHT. *Rev. Sci. Instrum.*, **20**, 573–4 (*Aug.*, 1949).

An automatic scanning mechanism is described for the study of preferred orientations in worked materials for pole figure representation. The device maintains a fixed specimen-to-film distance and permits tilting to 75 degrees from the normal to the

beam about horizontal and vertical axes. The yoke support is constructed to clear conventional film holders so that close specimen-to-film distances can be obtained. The sample holder can be easily removed and adapted to suit any specimen as required. An area of 2·38 cm²/hr is scanned when the beam is perp. to the plane of the specimen. A.

539.26

534. Reflection method of determining preferred orientation on the Geiger-counter spectrometer. M. Field and M. E. Merchant. *J. Appl. Phys.*, **20**, 741–5 (*Aug.*, 1949).

A rapid and accurate method of determining preferred orientation in the surface of thick samples was devised using a reflection technique on the Geiger-counter spectrometer. By presenting the specimen face to all possible angles with respect to the incident X-ray beam, through use of a special fixture, and recording the intensity of diffraction on a potentiometer recorder, the relative number of planes of a given set at each orientation can be determined. The change of intensity due to the positioning of the specimen face away from the Bragg angle is taken care of by a correction formula which is experimentally verified. The method is especially valuable for dealing with thin layers on thick specimens. A.

539.26 : 548.737

On the degree of crystallinity in natural rubber. III. *See Abstr.* 606–8

539.27

535. A device to deposit automatically the proper thickness of metals used in shadow-casting in electron microscopy. F. W. Bishop. *Rev. Sci. Instrum.*, **20**, 527–9 (*July*, 1949).

The amount of metal evaporated is gauged by measuring the decrease of resistance of an element so arranged that the metal is deposited on it as well as on the electron microscope specimen. The thickness of the deposit on the latter can therefore be checked and controlled. The elements used are burnt-out filament mounts from the R.C.A. electron microscope.

J. THEWLIS

539.27

536. A technique for the production of silica-filmed electron microscope screens in quantity. F. W. Bishop. *Rev. Sci. Instrum.*, **20**, 529–30 (*July*, 1949).

Describes a simple device for making collodion film and transferring it to specimen grids for the electron microscope. Very thin films can be produced upon which silica is evaporated to form a substrate for electron microscope specimens. Such a substrate, with its very thin collodion base, is rugged and structureless. J. THEWLIS

539.27

537. Interpretation of electron micrographs prepared by the plastic replica process. J. Trotter. Letter in *Nature, Lond.*, **164**, 227–8 (*Aug.* 6, 1949).

By depositing Cr 60–80 Å thick on a Formvar replica before stripping it from the underlying metal, it is shown that the upper surface of such a replica is not flat. In consequence, the interpretation of normal unshadowed replicas needs care whilst faithful records of the finer details of a surface can only be obtained by the shadowing technique.

H. J. H. STARKS

539.27

538. An improvement in the shadow-cast replica technique. S. J. Singer and R. F. Petzold. Letter in *J. Appl. Phys.*, **20**, 816–17 (*Aug.*, 1949).

It is noted that ethylcellulose is much superior to parlodion for the preparation of replicas by the evaporation technique, as it can be stripped from surfaces which invariably retain parlodion films.

A. H. W. BECK

539.27 : 537.533.72 : 535.82

539. New sectioning techniques for light and electron microscopy. S. B. Newman, E. Borysko and M. Swerdlow. *Science*, **110**, 66–8 (*July* 15, 1949).

A simple and inexpensive method is described for cutting very thin sections of tissue for examination by transmission at high magnifications in the light, phase contrast and electron microscope. The fixed biological material is embedded in an optically clear matrix of *n*-butyl methacrylate. A smooth continuous advance of the embedded specimen towards the knife of a Spencer microtome with its advancing mechanism disengaged is obtained by means of the thermal expansion of a simple brass specimen holder actuated by compressed CO_2. The main precautions necessary to obtain satisfactory results are the use of a very sharp knife, low temp. catalysts, curing temps. of 45–50°c during the polymerization of the embedding medium and fixing solutions of good hardening properties. H. J. H. STARKS

539.27 : 548.5

540. Electron-diffraction study on behaviours of metals deposited on crystal surfaces. III. Effect of centres of crystallization on crystal growth in metal films. M. Kubo and S. Miyake. *J. Phys. Soc. Japan*, **3**, 114–19 (*March–June*, 1948).

Two different metals were evaporated successively in the electron diffraction camera on to the surface of a zinc blende crystal and the effect of the first metal film on the crystal structure of the second was studied. The metals used were Ni, Au and Cu in various combinations. In the case of Cu deposited on Au a solid solution was sometimes formed. A discussion of the mechanism of crystal growth in the light of the experimental results is given.

M. R. HOPKINS

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31 : 538.65

541. Internal friction due to ferromagnetism. C. Boulanger. *Physica*, **15**, 266–71 (*April*, 1949) *In French.*

Measurements were made with a Coulomb–Chevenard micro-pendulum [P. Chevenard, *Rev. Métall.*, **38**, 273 (1941); **39**, 33, 65, 123 (1942)] on specimens of Fe, ferronickel and steel subjected to various fields up to about 1 000 oersted. The results

which are expressed in the form of curves of damping as a function of amplitude are reviewed in conjunction with the appropriate magnetic hysteresis curves.

G. F. HODSMAN

539.32

542. On determination of elastic constants from natural frequencies of bending vibration. J. R. WUOLIJOKI. *Publ. State Inst. Tech. Res. Finland* (*No.* 6) 3–9 (1948) *In English.*

It is assumed that an elastic bar has been brought into free bending vibration and some of its natural frequencies have been measured. With the aid of these frequencies the modulus of elasticity in tension and compression and the shear modulus can be determined for the material of the bar. A method is set forth for determining the moduli mentioned and the necessary computation chart for it is given, based on bars representing 3 different slenderness ratios. The method is illustrated by a numerical example based upon a test series. A.

539.32

543. Analysis of the temperature coefficient of shear modulus of aluminium. T. S. KÊ. Letter in *Phys. Rev.*, **76,** 579 (*Aug.* 15, 1949).

Measurements were made of the frequency of torsional vibration of an Al single crystal within the temp. range 20–450°C and it was found the temp. coeff. of the shear modulus ($d \ln G/dT$) was $-6{\cdot}8 \times 10^{-4}$ deg.$^{-1}$. It was deduced that this temp. coeff. is given by the relation: $d \ln G/dT = (\partial \ln G/\partial \ln V)_T . d \ln V/dT + (\partial \ln G/\partial T)_V$. Work by other authors gives $(\partial \ln G/\partial \ln V)_T = -5{\cdot}64$ and the average volume expansion coeff. is $8{\cdot}0 \times 10^{-5}$ from which the first term on the right-hand side of the above relation comes to $-4{\cdot}5 \times 10^{-4}$, and thus $(\partial \ln G/\partial T)_V = -2{\cdot}3 \times 10^{-4}$. The explicitly temp.-dependent term thus contributes more than ¼ of the total temp. coeff., from which it is deduced that the shear modulus is not a sole function of volume.

A. C. WHIFFIN

539.32 : 539.89

544. The variation of the adiabatic elastic constants of KCl, NaCl, CuZn, Cu and Al with pressure to 10 000 bars. D. LAZARUS. *Phys. Rev.*, **76,** 544–53 (*Aug.* 15, 1949).

The adiabatic velocities of sound for longitudinal and transverse waves in single crystal specimens of 5 cubic solids have been measured as a function of pressure to 10 000 bars, using a pulse technique [1 bar = 10^6 dynes]. The elastic constants calculated from these data in general agree well with previous measurements obtained for zero pressure elastic constants and compressibilities. With increasing pressure the anisotropy increases in crystals which are not closest-packed, but decreases in closest-packed structures. Consideration of the exchange force between nearest neighbours gives a qualitative explanation for this effect. Comparison of the present measurements with previous measurements of the variation of elastic constants with temp. indicates that the elastic moduli cannot be considered functions of volume alone but must also depend explicitly on the temp. A.

539.37

545. An elastic theory of dislocations. E. H. MANN. *Proc. Roy. Soc. A,* **199,** 376–94 (*Nov.* 7, 1949).

A theory is presented with the intention of describing the internal stresses set up by slip processes in crystalline materials. It is based on the concept of dislocations as they occur in the mathematical theory of elasticity, and follows on the work of Volterra. The present theory starts from the assumption that only the 3 stress components which act across surface in an elastic body need be continuous at that surface. This less restrictive condition on the stresses makes possible a more general type of dislocation, one with arbitrary elastic discontinuities of displacement. The theory is stated in cylindrical polar co-ordinates and general formulae are derived for calculating the stresses corresponding to given dislocations. Some examples are solved completely involving plane and screw dislocations in circular cylinders. The relation between the mathematical dislocations and some simple types of slip in crystals are described, and certain equivalent systems of dislocations explained. It is shown that if the slip bands in a deformed crystal are replaced by the appropriate dislocations, the stresses in the remaining elastic region may be calculated by means of this theory. A.

539.374

546. Elasto-plastic problem of the non-biharmonic plastic state. O. S. PARASYUK. *Dokl. Akad. Nauk SSSR,* **63** (*No.* 4) 367–70 (1948) *In Russian.*

An infinite plane with a circular aperture is under external forces applied to the contour of the aperture and extending along two rectangular directions to infinity. A plastic zone is assumed to exist around the aperture. The two possible biharmonic cases were solved by Galin and Mikhlin, respectively. The problem requires the determination of a contour surrounding the plastic zone (within which Mikhlin's solution obtains) and of 2 holomorphic functions satisfying certain conditions. It is assumed that the external region of the contour of the z-plane admits of a representation on the external region of the unit circle by means of the ζ-function. The given conditions are transformed accordingly, and on Harnack's theorem, written in form of a contour integral, thus enabling the solution of the problem to be found by complex integration. When one of the 4 arbitrary constants is assumed to vanish, the solution degenerates to Galin's solution. B. F. KRAUS

539.374 : 538.221 : 548.572

547. A new method of studying the plastic deformation of ferromagnetic crystals. N. S. AKULOV AND N. Z. MIRYASOV. *J. Tech. Phys., USSR,* **18,** 389–94 (*March,* 1948) *In Russian.*

The "deposition lines" on ferromagnetic crystals are connected in a definite way with the crystallographic directions. These lines also determine the degree and character of the residual stresses in the crystal and, consequently, enable the distribution of the latter to be referred to the crystallographic directions. The existence of two independent systems of deposition lines was proved, each of which characterizes a definite mechanism and degree of residual deformation. When the plastic deformation of the crystal is increased, qualitative and quantitative

changes of the character of the deposition figures are found. The results of these observations make possible a systematic investigation of the magnitude of the plastic deformation for ferromagnetic mono- and polycrystals under a complex system of stresses. The new method was found to be much more sensitive and to supply a far more complete description of the plastic deformation quantitatively and qualitatively than any other method. B. F. KRAUS

539.374

548. A generalization of the stress-strain relation in viscous-elastic solids. F. Levi. *Ric. Sci.*, **19**, 368–73 (*May*, 1949) *In Italian.*

A model of a viscous-elastic solid is suggested in which the substance is assumed to be homogeneous as far as external forces are concerned, while, to determine the stress-strain relation in any fibre, the fibre is considered to be made up both of a number of longitudinal elastic elements and a number of viscous-elastic ones, uniformly distributed in the section. For the latter it is further assumed that if ε_0 is the viscous deformation under unit stress and ε that under any stress σ, $d\varepsilon/dt = \sigma\, d\varepsilon_0/dt$.

L. PINCHERLE

539.374

549. A new theory of plastic flow. D. Trifan. *Quart. Appl. Math.*, **7**, 201–11 (*July*, 1949).

The stress-strain relation $s^*_{ij} = 2G_0\varepsilon^*_{ij} - p(E)E^*\varepsilon_{ij}$ is assumed, where s_{ij} is the stress deviation, ε_{ij} the strain tensor, E the strain intensity, $p(E)$ an arbitrary function and an asterisk indicates differentiation with respect to the time; for unloading $s^*_{ij} = 2G_0\varepsilon^*_{ij}$. The stress-strain curve for simple tension is expressed as a power series of the strain and the form of $p(E)$ is deduced. The boundary value problem for the strain rates corresponding to given surface velocities is formulated, uniqueness proved and the associated minimum principle discussed. A comparison is made with a plastic deformation theory which assumes $s_{ij} = 2G'\varepsilon_{ij}$ where G' is the secant shear modulus and is a function of the strain-intensity.

J. E. CAFFYN

539.374

550. Dynamic mechanical properties of polymer-plasticizer system. L. Nielsen and R. Levreault. Letter in *Nature, Lond.*, **164**, 317–18 (*Aug.* 20, 1949).

Polyvinyl chloride-phthalic acid esters were investigated over a temp. range 86°C to −15°C. The rigidity modulus and log. dec. were determined from torsional oscillations and Young's modulus and damping from the resonance frequency and the ½-width of the resonance peak of the forced vibrations of a reed. Polystyrene and plasticized polystyrene show a correlation between damping and creep.

J. E. CAFFYN

539.382 : 620.172 : 621.317.39

551. Stress-strain-time apparatus for fiber testing. C. H. Reichardt, H. Schaevitz and J. H. Dillon. *Rev. Sci. Instrum.*, **20**, 509–16 (*July*, 1949).

A stress-strain apparatus for testing individual fibres is described. The apparatus employs a ring dynamometer in conjunction with a linear variable differential transformer. A constant rate of elongation apparatus is fully described and a schematic diagram of a constant-rate-of-loading apparatus is discussed. The use of linear variable differential transformers allows simple a.c. amplifiers to be employed and thus removes many of the difficulties involved in d.c. bridge circuits. Load ranges from 50 g to 1 g per 10 chart inches can be obtained with a sensitivity of several mg. By changing the size of the ring dynamometer employed, an apparatus giving the greater load ranges necessary to test yarns can be constructed. A.

539.4 : 535.551

The similarity and model laws in photo-elastic experiments. *See Abstr.* 209

539.5 : 548.0

Surface effect and structure of single crystal wires. *See Abstr.* 586

539.501

552. Rheological properties of greases containing calcium. G. V. Vinogradov and K. I. Klimov. *J. Tech. Phys., USSR*, **18**, 355–76 (*March*, 1948) *In Russian.*

A method is described and results are reported of a study into the elasto-plastic properties of solidols. Properties considered included: the character of the elastic deformations under constant and varying loads; the conditions for determining the strain modulus of greases; creep phenomena and elastic after-effect, yielding and solidification under strain, elastic hysteresis and thixotropy; influence of temperature changes on the kinetics of the deformation of the greases; yield limit and plastic deformations. The conditions for determining limiting stresses and strains (yield limit) of greases in capillaries and in an apparatus with a co-axial cylinder arrangement were defined and the influence of the flow-parameter of the grease on these conditions found. (Bibliography of 46 entries.) B. F. KRAUS

539.501 : 541.183.6.025

553. Flow properties of dispersions of calcium soaps in hydrocarbon oil. G. B. Moses and I. E. Puddington. *Canad. J. Res. B*, **27**, 616–28 (*July*, 1949).

The flow properties of dispersions of calcium soaps in hydrocarbon oils have been studied over a range of temp. from 35° to 90°C, and rates of shear from 500 to 16 000 sec^{-1} by extrusion through a capillary plastometer. The thixotropy of the system falls as the temp. is increased to 50°C and then rises to a max. at 65°C, after which it falls regularly. This behaviour is due to the thermal weakening of the thixotropic bonds, followed by a strengthening of these bonds due to incipient swelling on the surface of the soap. As the surface of the soap particles continues to swell, cohesion of the particles increases to such an extent that breakdown does not take place and the coeff. of thixotropy falls to very small values. The coeff. of thixotropy found by this method bears a linear relation to the hardness of the dispersion as determined by a falling cone. A.

539.501 : 666

554. The flow of glass. R. W. Douglas. *J. Soc. Glass Tech.*, **33**, 138–62 (*T*) (*June*, 1949).

The expression $\eta/T = Ae^{B/T}(1 + Ce^{D/T})$ has been

derived for the viscosity of glass as a function of temp. assuming that the flow of glass is controlled by the Si–O–Si bonds and that flow can occur when an O atom has 2 positions available to it. The factor in brackets arises from the change of atomic configuration with temp. In atomic arrangement the structure of water is very similar to that of fused silica, and as first check on the theory, it was shown that the above expression can be fitted very accurately to the observed values of viscosity of water as a function of temp. Moreover, the experimental values of A and B were found to be in close accord with those predicted. The trend of the values of the constants when Na_2O is added to SiO_2 was discussed qualitatively on the basis of published data on soda-silica glasses. In every case the qualitative predictions were confirmed, and again the magnitudes of A and B were of the right order. A.

539.531 : 666

555. The phenomenon of the hardening of glass. G. M. BARTENEV. *J. Tech. Phys., USSR*, **18**, 383–8 (*March*, 1948) *In Russian.*

A theory of the mechanism of the hardening of glasses and the part played by the T_g point is presented. The case of hardening of a glass sheet is treated as an example, cooling from either side according to Newton's law being assumed. It is shown that for regular cooling the internal stresses have a nearly cosinusoidal distribution. The dependence of the internal stresses during the hardening process on the hardening (max.) temp. was experimentally investigated, and it could be shown that the degree of hardening, from a certain temp. onwards, becomes constant. This agrees with the theory. The depth of the neutral layer and the ratio of the surface stresses to the internal stresses were also determined, and both found to agree with theory.

B. F. KRAUS

539.536 : 535.417

Interferometric examination of hardness test indentations. *See Abstr.* 200

539.61 : 541.183

556. Force of adhesion and energy of binding. L. P. GUASTALLA AND J. GUASTALLA. *C.R. Acad. Sci., Paris*, **228**, 1575–7 (*May* 16, 1949) *In French.*

A paraffin-coated plate is pushed through a water surface on which is a monolayer of a fatty acid. The force of adhesion (F) is measured [Abstr. 2764 (1949)] for various surface pressures (p) and the energy of binding (W) of film molecules to paraffin is calculated from $F = A - p - W$ (A is surface tension of pure water). W is in ergs per cm² and W_{mol} the energy of binding of a single molecule with paraffin can be calculated if the molecular area is known. It is assumed in the first instance that the molecular area in the film carried down by, and attached to, the plate, is the same as in the film on the water surface and it is then found, for a film of oleic acid, that W is almost constant at 43 ergs but W_{mol} varies with p from 22 to $14 \cdot 10^{-14}$ ergs. This was unexpected and further experiments were carried out with myristic acid. The curve F–p shows a discontinuity analogous to that of the myristic acid pressure-area curve (liquid condensed to liquid expanded film). The curve W_{mol}–p shows the same discontinuity. However, if allowance is made for the fact that the area per molecule in the film on water is changed when the film is attached to paraffin and further, that the change is slight for a liquid condensed film but large for a liquid expanded film, then the discontinuities in the above curves disappear.

J. IBALL

539.61 : 541.183

557. Rheological measurements and adhesion. E. W. J. MARDLES. Letter in *Nature, Lond.*, **164**, 324–5 (*Aug.* 20, 1949).

Rods and plates of various materials, but otherwise identical, were found to move through non-Newtonian liquids at different rates. This is explained as the result of surface adhesion. The results are discussed in relation to Hardy's work [Abstr. 1444 (1928)].

J. E. CAFFYN

539.61 : 534.321.9

558. Evaluation of adhesion by ultrasonic vibrations. S. MOSES AND R. K. WITT. *Industr. Engng Chem.*, **41**, 2334–8 (*Oct.*, 1949).

A direct quantitative method for measuring adhesion of organic coatings to both metal and non-metal substrata is described. The method and apparatus utilize an electrodynamic system for producing longitudinal ultrasonic vibrations in a metal cylinder. An organic film attached to the free end of the vibrating cylinder separates from the metal when the force due to acceleration exceeds the adhesion force at the interface. The accelerating force is determined by the frequency and the amplitude of vibration. The method promises to be readily applicable to many types of material. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM CHEMICAL REACTIONS 541.11/.12

541.115 : 536.666

559. Dissociation energies of carbon–hydrogen bonds in paraffins from bond-energies. G. GLOCKLER. Letter in *J. Chem. Phys.*, **17**, 749–50 (*Aug.*, 1949).

541.123.7

560. Coexistence relations of $n + 1$ phases in n-component systems. P. M. PEPPER. *J. Appl. Phys.*, **20**, 754–60 (*Aug.*, 1949).

In an investigation of the coexistence relationships of $n + 1$ phases in the isothermic-isobaric sections of n-component systems, Beck [Abstr. 857 (1946)] found that there are at most two coexistence patterns

possible. Furthermore, theoretically, only a well-chosen sample need be examined for the phases it contains in order to clarify the phase coexistence relationships of the $n + 1$ phases whose compositions are already known. The present paper gives formulae for calculating the composition of the "well-chosen sample." Supplementary formulae are given for the range of coexistence, in the composition space, for any n phases known to coexist. A.

541.126

561. The stability of detonation. H. EYRING, R. E. POWELL, G. H. DUFFEY AND R. B. PARLIN. *Chem. Rev.*, **45**, 69–181 (*Aug.*, 1949).

In many problems connected with the detonation of explosives the detailed structure of the reaction zone is unimportant. Among such problems are the estimation of the limiting detonation velocity and the characteristics of the accompanying air shock wave. In other phenomena, however, the reaction zone is all-important: such are, for example, the variation of detonation velocity with charge geometry and the non-steady propagation immediately following initiation or preceding failure. This paper deals with phenomena of the second type. It is mainly theoretical, but some experimental results not hitherto available in open literature are included to illustrate the theory. The classical theory of detonation is critically reviewed. It is developed to treat steady detonation in finite charges, and non-steady detonation in general. The conclusion is reached that the chemical reaction in a solid explosive starts at load-bearing points of contact between grains, that it proceeds only at the grain surface, and may be diffusion-controlled. A study is made of initiation by impact; it is postulated that the reaction starts with localized internal burning from which a detonation wave builds up. A full bibliography is given, though some of the references are to literature not generally available. A. SCHOFIELD

541.126

562. Initiation of explosion in liquids. Transient pressures during impact. P. GRAY. Letter in *Research, Lond.*, **2**, 392–3 (*Aug.*, 1949).

An apparatus, employing the piezoelectric effect, has been developed to record the transient pressures in liquids subject to impact. The effects of the high transient temps. produced by these high pressures are mentioned in connection with the detonation of explosives by impact. G. O. BAINES

541.126 : 536.46

The laws of combustion of colloidal powders. *See Abstr.* 229

541.126.2

563. The ignition and flame reactions of ethylene oxide. F. A. BURDEN AND J. H. BURGOYNE. *Proc. Roy. Soc. A*, **199**, 328–51 (*Nov.* 7, 1949).

Spontaneous ignition pressure-temp. relationships of C_2H_4O–O and air mixtures have been studied. A low-temp. ignition system exists and cool flames can be initiated in air at atmospheric pressure and below. The propagation of cool flames through cold mixtures under this condition has not, however, been observed. A.

541.127.3 : 529.23

Theory of the oxidation of metals. *See Abstr.* 532

ELECTROCHEMISTRY 541.13

541.133.1 : 539.16

564. A rapid electrical method of separating carrier-free radioactivities. W. M. GARRISON, H. R. HAYMOND AND R. D. MAXWELL. Letter in *J. Chem. Phys.*, **17**, 665 (*July*, 1949).

The method employs ionic migration.

A. O. STANESBY

541.135.2

565. Note on the theory of non-stationary phenomena in electrolytic solutions. M. DRĂGANU. *C.R. Acad. Sci., Paris*, **228**, 469–71 (*Feb.* 7, 1949) *In French.*

A system of integro-differential equations is given describing the statistical distribution in time of ions in the non-stationary state. The equations, which take into account the kinetic energies of the ions, approximate to those of Debye and Falkenhagen if the effect of interionic collisions is considered to be of second-order importance. J. O'M. BOCKRIS

541.135.5 : 541.14

566. On overpotential and the photovoltaic process at polarized electrodes. P. J. HILLSON AND E. K. RIDEAL. *Proc. Roy. Soc. A*, **199**, 295–310 (*Nov.* 7, 1949).

The acceleration of the electrodeposition of H and O by light of wavelength from 4 000 to 2 000 Å has been studied on different electrodes. The quantum efficiency of the photoreaction was determined as a function of the wavelength of the incident light and of the steady polarizing current. It was concluded that the rate-determining step at these electrodes occurred after the discharge of the ions and that the overpotential corresponded to a stationary concentration of adsorbed atoms or radicals. It was further concluded that an electrode at which H is being evolved at a sensible rate is covered with a nearly complete layer of adsorbed H. The potential at which such evolution occurs is determined primarily by the negative potential necessary to displace adsorbed O atoms or water molecules by H. Calculations of this potential, in the few cases where the necessary heats of adsorption are available, gave values in agreement with those observed experimentally. It was concluded that the rate-determining step on most cathodes, except Pt, was the electrochemical combination of an adsorbed atom with an ion in the double layer, and relations were obtained for the dependence of the overpotential on the current density and electrokinetic potential, which are in fairly good agreement with experiment. A similar mechanism is tentatively suggested for the electrode reaction at an anode at which O is being evolved. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14

541.141.1

567. The relative rates of photo-chlorination of $CHCl_3$ and $CDCl_3$. T. W. NEWTON AND G. K. ROLLEFSON. *J. Chem. Phys.*, **17**, 718–25 (*Aug.*, 1949).

DISPERSIONS . COLLOIDS ADSORPTION 541.18

541.182.3 : 535.434

568. Light scattering as a measure of particle size in aerosols. The production of monodisperse aerosols. D. SINCLAIR AND V. K. LA MER. *Chem. Rev.*, **44**, 245–67 (*April*, 1949).

A detailed account of the theoretical treatment of light scattering by aerosols is given and applied to determinations of particle size by methods based on measurement of (1) transmission, (2) intensity, (3) colour, (4) polarization. A technique for the production of monodisperse aerosols is described.

R. F. BARROW

541.182.4

569. Globule size in two-phase emulsions. C. G. SUMNER. Letter in *Nature, Lond.*, **164**, 364–5 (*Aug.* 27, 1949).

Contrary to the conclusions of Lewis [*Trans. Faraday Soc.*, **28**, 597 (1932)] and of Knapp [*ibid.*, **17**, 457 (1922)], calculations show that no balance between electrical and capillary forces is possible at a particle surface where there exists an electrical double layer in equilibrium with the environment.

R. F. BARROW

541.182.6

570. Suspensions and sedimentation. S. G. WARD. *Nature, Lond.*, **164**, 220–2 (*Aug.* 6, 1949).

A discussion. Papers read covered: the apparent viscosity of suspensions of glass spheres and methyl methacrylate polymer spheres, sedimentation of non-flocculated systems, viscosity and settlement of precipitated calcium carbonate in organic liquids and the rheology of blood. J. E. CAFFYN

541.182.6

571. Low temperature studies with colloidal silicic acid. F. HAZEL, J. A. PARKER AND E. SCHIPPER. *Science*, **110**, 161–2 (*Aug.* 12, 1949).

A brief summary is given of several observations on the thermal behaviour of silica sols which appear to be related to the properties of ice. A sol frozen in liquid air can be held for any length of time below −55°C and will not coagulate if thawed rapidly, but if frozen and then transferred to above −55° but below m.p. and held there, it coagulates irrespective of the rate of thawing. S. WEINTROUB

541.182.6 : 534.321.9

572. Dispersion of clay suspensions by ultrasonics. Interpretation of the results by the electron microscope. A. MATHIEU-SICAUD AND G. LEVAVASSEUR *C.R. Acad. Sci., Paris*, **228**, 393–5 (*Jan.* 31, 1949) *In French.*

Curves are given showing that the degree of dispersion varies with the frequency of the ultrasonic wave and passes through a max. at 960 kc/s for kaolin and 320 kc/s for montmorillonite. Distribution curves of particle size are given which are obtained by an electron microscopic examination of kaolin suspensions stabilized chemically and also as treated with ultrasonics. There is correspondence between ultrasonic frequency and particle size. For montmorillonite where the particles are larger, the dispersive frequency is lower and the action of ultra-sonics is less effective. G. F. HODSMAN

541.183.5 : 534.321.9

573. The influence of ultrasonic radiation on the adsorption of fatty acids by fine-grained carbon. K. V. CHMUTOV AND N. G. ALEKSEEV. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 2) 321–3 (1949) *In Russian.*

Solutions of propionic, valerianic and heptylic acids were adsorbed on large-grained and fine-grained carbon and on carbon black; the influence of ultra-sonic irradiation on the quantity adsorbed was measured. If the acids are arranged in the order of quantity adsorbed, ultrasonic irradiation alters the sequence on fine-grained carbon only and with this material the quantity adsorbed is increased much more by irradiation than with coarse-grained carbon. Adsorption on carbon black is not affected by irradiation. These effects are attributed to increase in mobility of the acid molecules by the removal of steric hindrances; the acid molecules being, as it were, shaken down into the pores of the adsorbent by irradiation. W. R. STOKER

541.183.6.025 : 539.5011

Flow properties of dispersions of calcium soaps in hydrocarbon oil. *See Abstr.* 553

CHEMICAL STRUCTURE 541.4/.6

541.571

574. Comparison of relations between covalent bond order, energy, and interatomic distance for carbon–carbon bonds. J. L. KAVANAU. *J. Chem. Phys.*, **17**, 738–9 (*Aug.*, 1949).

The results given by the relations of Bernstein, Gordy and the author between interatomic distance and energy and order are compared for C–C bonds. The predictions of these relations for the benzene and graphite bond orders are compared with the results given by quantum mechanical calculations, while those for the energies are compared with experimental values. A.

541.64 : 535.566

575. The use of polarized infra-red radiation in the study of doubly oriented long-chain polymers. E. J. AMBROSE, A. ELLIOTT AND R. B. TEMPLE. *Proc. Roy. Soc. A*, **199**, 183–98 (*Oct.* 25, 1949).

It is shown that infrared spectroscopy can furnish evidence for double orientation in rolled sheets of nylon 66, polyvinyl alcohol and (with less certainty) polythene. In the case of polyvinyl formate, acetate, chloride and polyvinylidene chloride such double orientation could not be detected. Evidence is given to show that in nylon the N–H bond is bent by H bonding forces, the angle between this bond and the plane of the skeleton being thereby reduced from 39° (the valency angle) to 22°. The structure of polyvinyl alcohol recently proposed by Bunn receives strong support from the absence of dichroism in the O–H frequency in the spectrum of that material, when a doubly oriented specimen is examined. A.

542.48

576. Distillation of an indefinite number of components. J. R. BOWMAN. *Industr. Engng Chem.*, **41**, 2004–7 (*Sept.*, 1949).

The fundamental equations of distillation theory are generalized to apply to systems formally composed of an infinite number of components. The results apply to systems of any number of components, because the elements of the general infinite set are arbitrary and not necessarily all different. Compositions are designated by functions of the form $x(\alpha)$, where α is the classical relative volatility; the functions x have the property that the amount of material in the compositions they represent, having α between α and $\alpha + d\alpha$, is $xd\alpha$. All concentrations are therefore of the form xdx, and material balances are accordingly set up on a differential basis. Since material balances and idealized equilibrium relations are linear and homogeneous in the concentrations, however, the factors $d\alpha$ divide out, and the fundamental equations of distillation on the present basis are formally similar to the classical ones. A.

542.48

577. Fractional distillation of multicomponent mixtures at variable reflux ratio. W. R. VAN WIJK. *Physica*, **15**, 634–48 (*Aug.*, 1949) *In English.*

A method is given for making distillation calculations at variable reflux, if the volatilities in top and bottom section have a constant ratio. The ratios in each section may be different. The molal heat contents of the components in the liquid and vapour state are approximated by a hyperbola in the temp. range of the distillation and extrapolated, if necessary, to the boiling temp. of the component. These values are used for the definition of generalized flow rates. The distillation at variable reflux is entirely similar to a distillation at constant reflux if the generalized flow rates are substituted for the liquid and vapour flow rates in the latter case. The same graphical or analytical solution methods can be applied. In case of a two component mixture, the ratio of volatilities may vary. A.

545.8 : 539.16.08

578. Assay of the uranium content of minerals by measurement of nuclear radiations. J. THOMMERET. *J. Phys. Radium*, **10**, 249–52 (*July–Aug.–Sept.*, 1949) *In French.*

The Ra and U contents of a finely powdered 100 g sample of a Th-free mineral in radioactive equilibrium are obtained separately by measurement of the γ-(Ra + descendants) and β-activity (Ra + UX); the lowest measurable conc. of U is $\sim 0{\cdot}001$.

A. O. STANESBY

545.82

579. The spectroanalytic estimation of iron in zinc blend. F. ROST. *Spectrochim. Acta*, **3** (*Nos* 5–6) 569–74 (1949) *In German.*

545.82

580. Preparation and purification of carbon electrodes for spectral analysis. A. S. BRETÓN. *An. Real. Soc. Esp. Fis. y Quím. A*, **45**, 261–9 (*May–June*, 1949) *In Spanish.*

Short critical review.

545.82

581. A common-matrix system of spectrochemical analysis. J. R. WEAVER AND R. R. BRATTAIN. *Analyt. Chem.*, **21**, 1038–41 (*Sept.*, 1949).

A general method of emission spectrochemical analysis is described which is applicable to any inorganic material. Lithium carbonate, which acts as a flux and diluent, is used to modify extensively the effects of different major constituents present in the samples. The method is rapid, uses only a small amount of sample, and yields results that are usually correct within a factor of 2. A.

545.82

582. Direct spectrochemical analysis of solutions using spark excitation and the porous cup electrode. C. FELDMAN, *Analyt. Chem.*, **21**, 1041–6 (*Sept.* 1949).

545.827

583. Mass spectrometric study of a mixture of deuterated acetaldehydes. R. K. BRINTON AND F. E. BLACET. *J. Chem. Phys.*, **17**, 797–800 (*Sept.*, 1949).

CRYSTALLOGRAPHY 548

548.0 : 537.226.2

584. Dielectric constants of crystals. III. D. A. A. S. NARAYANA RAO. *Proc. Indian Acad. Sci. A*, **30**, 32–6 (*Aug.*, 1949).

The permittivities of 15 crystals belonging to different systems are determined and reported together with previous values. Some of the values are found to be different from those reported by earlier investigators. Different specimens of tourmaline are found to have widely different permittivities. A.

548.0 : 537.529

585. Breakdown of ionic crystals by electron avalanches. A. VON HIPPEL AND R. S. ALGER. *Phys. Rev.*, **76**, 127–33 (*July* 1, 1949).

In gases at moderate pressures breakdown occurs when the avalanche produced by a primary electron regenerates with certainty a new starting electron (Townsend condition). In ionic crystals the breakdown strength appears to be determined by the probability of exciting lattice vibrations, without reference to the electron supply. The theory as formulated to date predicts an increase of the breakdown strength with temp. Confirming previous results an increase followed by a decrease is found for both d.c. and a.c. By extending the experiments to transient voltages of rise times down to 10^{-8} sec, and by adopting evaporated metal electrodes and various kinds of irradiation, the influence of field emission and of space charges on the breakdown strength and on the scatter of the breakdown values

has been investigated. The occurrence of directional breakdown paths seems to be connected with the Brillouin zones of the crystal structure as the outcome either of electron diffraction or of collisions between electrons and directed lattice vibrations. The possibility of using crystals as Geiger counters is briefly discussed. A.

548.0 : 539.5

586. Surface effect and structure of single crystal wires. E. N. DA C. ANDRADE. Letter in *Nature, Lond.*, **164**, 536–7 (*Sept.* 24, 1949).

The effect of electrolytes, applied to the surface of single crystals of Cd, on the rate of flow under stress [Abstr. 5102 (1949)] is attributed to the action of the electrolyte on surface films. A. E. DE BARR

548.0 : 539.554

587. The character of the decomposition of crystals [Phenomena of cleavage and separability]. N. V. BELOV AND M. V. KLASSEN-NEKLYUDOVA. *J. Tech. Phys., USSR*, **18**, 265–78 (*March*, 1948) *In Russian.*

548.4

588. Edge dislocations in anisotropic materials. J. D. ESHELBY. *Phil. Mag.*, **40**, 903–12 (*Sept.*, 1949).

Expressions are derived for the displacements and the energy of a dislocation of edge type, with an infinite straight line as axis. These apply to a material with the symmetry of any of the crystal classes. Nabarro's calculation of the width of a dislocation [Abstr. 619 (1940)] is extended to the anisotropic case. L. S. GODDARD

548.5 : 539.27

On crystal growth in metal films. *See Abstr.* 540

548.51 : 536.421.4

589. Crystallization of supercooled liquid selenium. G. BORELIUS. *Ark. Fys.*, **1**, *Paper* 13, 304–22 (1949) *In English.*

The rate of growth of crystals in supercooled Se increases with temp. below 90°c., is constant between 90 and 190°c, and decreases between 190°c and the melting point. These ranges roughly coincide with the microscopically observed ranges for the growth of spherulites, dendrites and grains. The effect of heat treatment on the rate of growth and the number of spherulites was studied with a reflection microscope. The rate of dendritic growth was observed with a microscope and found to vary by a factor 70 in different crystal directions. A theoretical discussion is given of the temp.-dependence of the crystallization velocity. J. A. FRANKS

548.52

590. Forms of equilibrium of crystals. I. N. STRANSKI. *Disc. Faraday Soc.* (*No.* 5) 13–21 (1949).

The treatment of equilibrium forms can either be based on the Thomson–Gibbs relation or on the estimation of the work of separating individual crystal units from the crystal surface. The second method has a more universal application and is simpler to visualize. Equilibrium forms are given for some ionic and non-polar crystals. The relation between equilibrium form and growth form is briefly discussed. J. A. FRANKS

548.52

591. The synthesis of crystals produced in gaseou media by detonation of explosive mixtures. A MICHEL-LÉVY. *Disc. Faraday Soc.* (*No.* 5) 325- (1949).

548.52

592. Growing single crystals from solution. A. M HOLDEN. *Disc. Faraday Soc.* (*No.* 5) 312–15 (1949

548.52

593. The growth of large crystals of ammoniu dihydrogen phosphate and lithium sulphate. A. I ROBINSON. *Disc. Faraday Soc.* (*No.* 5) 315–19 (1949

548.52

594. Controlled growth inhibition in large-scal crystal growth. H. JAFFE and B. R. F. KJELLGRE *Disc. Faraday Soc.* (*No.* 5) 319–22 (1949).

548.52

595. Hydrothermal synthesis of minerals. J. WYAR *Disc. Faraday Soc.* (*No.* 5) 323–4 (1949).

548.52

596. Factors governing the growth of crystalli silicates. R. M. BARRER. *Disc. Faraday Soc.* (*No.* 326–37 (1949).

548.52

597. The hydrothermal crystallization of vitreo at constant temperature. G. VAN PRAAGH. *Dis Faraday Soc.* (*No.* 5) 338–41 (1949).

548.52

598. The hydrothermal synthesis of quartz. L. A THOMAS, N. WOOSTER AND W. A. WOOSTER. *Dis Faraday Soc.* (*No.* 5) 341–5 (1949).

548.5

599. Relation between the existence of imperfec tions in the structure of single crystals of pu aluminium and of Al–Zn alloys and the processes recrystallization. P. LACOMBE AND A. BERGHEZA *Physica*, **15**, 161–7 (*April*, 1949) *In French.*

It is shown that the mosaic structure revealed Al by suitable etching after straining and annealin is also found in Al–Zn alloys containing 8–12% Z and that the structure is not due to ageing but to th manner of recrystallization. A. E. DE BAR

548.5

600. Discussion on "Relation between the existen of imperfections in the structure of single crystals pure aluminium and of Al–Zn alloys and the process of recrystallization." A. GUINIER AND J. TENNEVI *Physica*, **15**, 167–9 (*April*, 1949) *In French.*

An experimental procedure, based on the La method, is described for examining the texture single crystals and it is shown that the mosaic structu revealed by etching is due to recrystallization small units with slightly different orientations.

A. E. DE BAR

548.5

601. Influence of magnetic field on recrystallizatio R. SMOLUCHOWSKI AND R. W. TURNER. *J. Ap Phys.*, **20**, 745–6 (*Aug.*, 1949).

In order to gain additional information about t origin of preferred orientation of recrystallized grai the influence of a magnetic field on recrystallizati of Fe–Co alloys is being studied. Prelimina results indicate a change of the texture which can qualitatively accounted for by considering t

magnetostrictive properties of the alloy and their influence on the stability of the recrystallization centres. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 530.145.6

602. Symmetry properties of wave functions in crystals. I. Two-dimensional lattice. T. VENKATARAYUDU AND T. S. G. KRISHNAMURTY. *Proc. Indian Acad. Sci. A*, **29**, 137–47 (*March*, 1949).

The symmetry properties of wave-vectors are described in detail for all types of 2-dimensional lattices in order to examine the Wigner sticking of the Brillouin zones. G. J. KYNCH

548.7 : 530.145.6

603. Symmetry properties of wave functions in crystals. II. Three-dimensional lattices. T. VENKATARAYUDU AND T. S. G. KRISHNAMURTY. *Proc. Indian Acad. Sci. A*, **29**, 148–61 (*March*, 1949).

The symmetry properties of wave vectors given previously for 2-dimensional lattices [above Abstr.], in relation to the sticking of Brillouin zones, are stated for all 3-dimensional lattices except those in the cubic system. G. J. KYNCH

548.7 : 532.6

Quantitative study of the Bragg "bubble model." *See Abstr.* 82

548.7 : 535.375.5

Coupling of external oscillations in a crystal. *See Abstr.* 189

548.7 : 537.226

Properties of barium titanate in connection with its crystal structure. *See Abstr.* 249

548.7 : 539.11

Electronic eigenfunctions in ionic crystals. *See Abstr.* 407

548.7 : 539.434

604. Distribution of solute atoms around a slow dislocation. A. H. COTTRELL AND M. A. JASWON. *Proc. Roy. Soc. A*, **199**, 104–14 (*Oct.* 7, 1949).

The factors determining the average velocities of solute atoms attracted to a dislocation are discussed, and an equation is set up for the concentration of solute round the dislocation. This leads to a symmetrical distribution of a Maxwell–Boltzmann type round a stationary dislocation. In the case of a slowly moving dislocation the distribution is given as a series solution in Mathieu functions, and the non-symmetry of this distribution causes a force on the dislocation, opposing its motion. This force is calculated and shown to increase linearly with the speed of the dislocation, at low speeds, and a critical range exists above which the motion is unstable and the dislocation accelerates. The characteristics of the plastic flow below this critical range are compared with those of micro-creep in Sn crystals and are shown to be similar. Quantitative agreement can be obtained by assuming plausible values for the density of dislocations and the rate of diffusion of solute atoms in Sn, but the need for further experiments on micro-creep is emphasized. A.

548.736.6

605. Mineralogy and crystal structure of chamosite. BRINDLEY, G. W. Letter in *Nature, Lond.*, **164**, 319–20 (*Aug.* 20, 1949).

Chamosite, a hydrous ferrous silicate, appears to have a kaolin-like structure, contrary to the conclusion of Engelhardt [*Z. Krist*, **104**, 142 (1942)]. Probably both a hexagonal and a monoclinic form exist, and random layer sequences occur. The lattice dimensions are: orthohexagonal $a = 5{\cdot}38$, $b = 9{\cdot}314$, $c = 7{\cdot}026$; monoclinic $a = 5{\cdot}40$, $b = 9{\cdot}314$, $c \sin \beta = 7{\cdot}026$ kx, $\beta = 104{\cdot}5°$.

A. J. C. WILSON

548.737 : 539.26

606. On the degree of crystallinity in natural rubber. III. Correlation between X-ray and density measurements. J. J. ARLMAN. *Appl. Sci. Res.*, **A 1** (*Nos* 5–6) 347–52 (1949).

The results of X-ray and density measurements on crude rubber are given. It is shown that in order to measure the correct degree of crystallization it is necessary to use monochromatic X-rays. A.

548.737 : 539.26

607. On the degree of crystallinity in natural rubber. IV. The degree of crystallization in frozen raw rubber and stretched vulcanized rubber. J. M. GOPPEL and J. J. ARLMAN. *Appl. Sci. Res.*, **A 1** (*Nos* 5–6) 462–74 (1949).

An improved X-ray technique has been worked out to determine the degree of crystallinity in natural rubber. Inaccuracies which sometimes occur in quantitative X-ray measurements were eliminated and it has been shown that the amount of crystalline rubber, both in frozen samples of raw rubber and in stretched vulcanized rubber, could be determined fairly accurately. More experiments were carried out and the results are described. These results, which confirm the current views on the problem of crystallization, point to relatively low degrees of crystallization, even in highly stretched rubber, and they agree with some other experimental evidence and with theoretical investigation. A.

548.737 : 539.26

608. On the degree of crystallinity in natural rubber. V. A discussion of the X-ray results on natural rubber in connection with the work of Flory, Gee and Wildschut. J. J. ARLMAN AND J. M. GOPPEL. *Appl. Sci. Res.*, **A 2** (*No.* 1) 1–30 (1949).

A recent theory, developed by Flory [Abstr. 2689 (1947)] allows the degree of crystallization to be calculated from thermodynamical measurements if certain parameters are properly evaluated. Such evaluation is possible by combining Wildschut's thermodynamical measurements [Abstr. 1367 (1946)] with the X-ray results presented in previous papers. Thus, the average length of molecule chains between cross-linkages can be derived; it closely corresponds to the results of swelling measurements, carried out by Gee [*J. Polymer. Sci.*, **2**, 451 (1947)]. Other parameters are also evaluated in agreement with their physical meaning. A.

548.74

609. Single-crystal patterns in electron diffraction. H. WILMAN. *Research, Lond.*, **2**, 352–62 (*Aug.*, 1949).

A survey. Discusses the interpretation of spot patterns according to Laue, Ewald and Bragg; and considers the effects of crystal thickness, secondary scattering, refraction, depth of penetration, etc. Thermal effects are also dealt with and particular attention is paid to the interpretation of Kikuchi lines. J. THEWLIS

548.74

610. Neutron diffraction by crystals. K. LONSDALE. *Nature, Lond.*, **164**, 205–9 (*Aug.* 6, 1949).

Surveys the work done up to date on the diffraction of neutrons by crystals, giving an account of the interaction of neutrons with matter, and the experimental methods used for their production, diffraction and detection. The results of neutron diffractio experiments are also summarized and references t 24 original papers are given. J. THEWLI

548.74 : 537.533.7

611. Electron diffraction on a "bent" mica crysta M. A. RUMSH. *J. Tech. Phys., USSR*, **18**, 289–9 (*March*, 1948) *In Russian.*

The inadmissibility of the method of the invers lattice and Ewald's sphere for explaining electro diffraction [see Finch and Wilman, *Trans. Farada Soc.*, **32**, 1539 (1936)] is stated and proved. Th theoretical foundation for a treatment of the proble may, in the author's opinion, be found in Fock an Kolpinski's paper on the summation of the amplitude of the diffracted waves when the diffraction centre lie on a cylindrical surface [*J. Exp. Theor. Phys.*, **1** (*No.* 2) (1940)]. Even this theory is applicable onl to simple cases. B. F. KRAU

GEOPHYSICS 55

550.312

612. Gravity in the interior of the earth. R. M. STEWART. *J. Roy. Astr. Soc. Can.*, **43**, 129–37 (*July–Aug.*, 1949).

General formulae are developed which show the manner in which the existence of max. and min. of gravity in the interior of the earth is dependent on the variation of density with distance from the earth's centre. Several special cases are discussed among which is the assumed approximation of a succession of layers, each of uniform density, separated by definite surfaces. A.

550.312

613. Isostasy and its meaning. B. GUTENBERG. *Tellus*, **1**, 1–5 (*Aug.*, 1949).

The theory of isostasy supposes that, in regions which have not been disturbed recently, each vertical column of the earth's crust with a certain min. radius and extending to a depth of about 100 km has approximately the same mass. To find the deviation from this approximation in a given region, the density must be assumed as a function of depth. Such assumptions used at present for calculations are discussed critically. The resulting errors are greater than it is normally believed; errors in the calculated isostatic gravity anomalies exceeding 10 milligals must be expected in certain regions. Systematic errors result from the usual assumption in routine calculations that the mean density in the earth's crustal layers under the bottom of the Pacific and in the continental areas is the same, and that in both the difference between the density of the layers above about 30 km and the layers below this depth is 0·6. The processes producing and maintaining isostatic equilibrium are discussed. A.

550.34 : 532.51

Impulsive hydrodynamics of fluid. *See Abstr.* 78

550.361 : 620.92

614. On the thermal utilization of the soil. G. CLAUDE AND A.-G. CLAUDE. *C.R. Acad. Sci., Paris*, **228**, 544–5 (*Feb.* 14, 1949) *In French.*

An investigation of the available energy to be obtained by utilizing the temp. gradient in the earth Assuming a mean rate of temp. increase of 1°C/r a mean density of 2·5 and a specific heat 0·19 (min it is shown that for 1 m² of surface the availabl energy is $1{\cdot}97\times10^6$ cal. for a depth of 2 000 m risin to 97×10^6 cal. for 8 000 m. Comparison is mad with the total energy of the coal deposits in France Thus for 2 000 m depth the available energy i $> 12\times$ the total energy of the coal and for 8 000 m depth > 600 times. The extraction of this energ might be possible by means of thermo-artesian well suitably disposed. F. E. HOAR

550.38

615. An explanation of geomagnetic storm variation on the basis of ionization by collision. K. BURKHART *Naturwiss.*, **36** (*No.* 6) 185 (1949) *In German.*

The suggestion is made that the characteristi departures from normal values of the magneti elements observed during a typical storm are a resul of ionization in the high atmosphere (at *E*-region level by direct impact of high-energy particles associate with the incident solar stream. D. R. BARBE

550.8

616. An investigation of the applicability of gravi metric and magnetometric methods of geophysica prospecting. M. J. S. INNES. *Publ. Dom. Obs. Ottawa*, **9** (*No.* 10) 355–61 (1949).

An account of an investigation made with a gravit meter and magnetometer over sulphide concentra tions at East Sullivan, Quebec, 1947. The topographi relief over the area does not exceed 20 ft. The over burden varies from 0 to 50 ft. The west orebody ha been outlined by extensive drilling. The averag density contrast between the sulphide body an surrounding rocks is 0·5. 260 gravity and 19 magnetic stations were observed. The results ar shown on contour sketches. A detailed account i given of the methods employed to reduce the gravit observations. The survey shows that both grav metric and magnetic methods are useful in delineatin sulphide deposits. The results indicate that the burie contact of the syenite intrusive south-east of th

orebody could be traced with the gravimeter and that the magnetometer was of little value for that purpose. Gravity anomalies due to the varying depths of overburden are negligible as compared to the magnitude of the total anomalies. A.

550.837.3 : 621.317.39

617. Electric logging. E. F. STRATTON AND R. D. FORD. *Colo. Sch. Min. Quart.*, **44**, 302–39 (*July*, 1949).

Describes the method of recording the electrical log consisting of a spontaneous potential curve and generally 3 resistivity curves. The cause of anomalies is explained and typical annotated logs are shown for a variety of borings. A. C. COPISAROW

550.837.6 : 621.317.39

618. Induction logging and application to logging of wells drilled with oil-base mud. H. G. DOLL. *Colo. Sch. Min. Quart.*, **44**, 340–5 (*July*, 1949).

Description of the logging system employed where direct contact between the electrodes and drilling mud is not possible. A.c. of appropriate frequency is made to flow through a coil, referred to as a "transmitter." Eddy currents are generated which follow circular paths, coaxial with the hole and the coil system, in the formation surrounding the hole. These create a secondary magnetic field which induces an e.m.f. in a second coil, the "receiver." With constant transmitter current, the conductivity of the ground determines the signal generated in the receiver, hence the resistivity can be established.

A. C. COPISAROW

551.482

619. Observations on the turbulent fluctuations of a tidal current. K. F. BOWDEN AND J. PROUDMAN. *Proc. Roy. Soc. A*, **199**, 311–27 (*Nov.* 7, 1949).

ATMOSPHERE . METEOROLOGY 551.5

551.508.29 : 534.22

620. Preliminary report on temperature measurement by sonic means. E. W. BARRETT AND V. E. SUOMI. *J. Met.*, **6**, 273–6 (*Aug.*, 1949).

Following a brief review of the assumptions involved in the usual (Laplacian) expression for the speed of sound waves, an instrument, the sonic thermometer, is described which utilizes this relationship to measure the air temp. The advantages of the sonic thermometer are then discussed, the main advantages being the absence of radiational errors and extremely low lag—a result of the fact that the measured variable, the speed of sound, is independent of the properties of the measuring elements. A.

551.508.71

621. Mahajan's maximum and minimum hygrometers. L. D. MAHAJAN. *Indian J. Phys.*, **23**, 269–72 (*June*, 1949).

Two new types of hygrometers are described. They both work on the principle of Mahajan's optical hygrometer. [Abstr. 2058 (1947)]. A.

551.510.535 : 551.506.7 : 621.396.9.08

622. A radio method of measuring winds in the ionosphere. S. N. MITRA. *Proc. Instn Elect. Engrs, Pt III*, **96**, 441–6 (*Sept.*, 1949).

A pulse transmitter working on about 4 Mc/s is used in conjunction with 3 receivers placed at the corners of a right-angled triangle, and separated by distances of the order of 100 m. A simultaneous record is made of the fading of a single radio pulse reflected from the inosphere and received at the 3 receivers. If a steady wind is blowing in a non-turbulent ionosphere the 3 fading records are displaced in time and the velocity and direction of the wind can be deduced. Many of the records obtained are sufficiently simple for reliable deductions to be made. The results of 82 determinations of winds by the use of local pulse transmitters are presented in the form of histograms. The most frequent velocity is found to be ~ 50 m/sec in a direction towards *N.W.*, but there are clear indications that this velocity varies throughout the day, probably with a semi-diurnal period. The results are compared with previous measurements by other methods. Measurements were also made in which a distant pulsed transmitter was used in conjunction with the same arrangement of receiving aerials. In all the experiments care was taken to avoid the misleading conclusions which may be drawn when "polarization fading" occurs owing to the simultaneous presence of two magnetoionic components in the reflected pulse. A.

551.513

623. The general equations of the mechanics and energy of turbulent fluids with a view to their application to meteorology. J. VAN MIEGHEM. *Inst. Roy. Mét. Belg. Mém.*, **34**, 3–60 (1949) *In French.*

Starting from Prigogine's work on the thermodynamics of irreversible phenomena, the equations of the mechanics and thermodynamics of turbulent fluids in the form of balances are obtained. Use is made of this form of the equations to obtain *inter alia* the equation of the flux of heat due to turbulence and from it Smith's formula for the vertical flux of heat due to atmospheric turbulence. It is shown that the existence of Smith's flux and of the flux of heat due to thermal convection are not in contradiction with the second principle of thermodynamics.

M. DOPORTO

551.513

624. Long waves and cyclone waves. E. T. EADY. *Tellus*, **1**, 33–52 (*Aug.*, 1949).

By obtaining complete solutions, satisfying all the relevant simultaneous differential equations and boundary conditions, representing small disturbances of simple states of steady baroclinic large-scale atmospheric motion it is shown that these simple states of motion are almost invariably unstable. An arbitrary disturbance (corresponding to some inhomogeneity of an actual system) may be regarded as analysed into "components" of a certain simple type, some of which grow exponentially with time. In all the cases examined there exists one particular component which grows faster than any other. It is shown how, by a process analogous to "natural selection," this component becomes dominant in that almost any disturbance tends eventually to a definite size, structure and growth-rate (and to a characteristic life-history after the disturbance has ceased to be "small"), which depends only on the broad characteristics of the initial (unperturbed) system. The characteristic disturbances (forms of

breakdown) of certain types of initial system (approximating to those observed in practice) are identified as the ideal forms of the observed cyclone waves and long waves of middle and high latitudes. The implications regarding the ultimate limitations of weather forecasting are discussed. A.

551.515

625. The motion of barotropic disturbances in the upper troposphere. G. W. PLATZMAN. *Tellus*, **1**, 53-64 (*Aug.*, 1949).

551.515.4

626. Structure and dynamics of the thunderstorm. H. R. BYERS. *Science*, **110**, 291–4 (*Sept.* 23, 1949).

A very extensive radar investigation of the structure of thunderstorms, undertaken in America in 1946–47. The main details of the observation system consisted of a number of aircraft used as probes, a ground network of observing and radiosonde stations, and long-range radar to detect and select the storms for study as well as to guide the pilots and the balloon releases. An analysis of the observations shows that within a thunderstorm there are several distinct cells. The life cycle of a cell is found to consist of the stages, the cumulus stage, the mature stage and the dissipating stage. The behaviour of the air currents within and surrounding the cells at the various stages has been investigated. Turbulence was found to be greatest within the cells between 15 000 and 20 000 ft and least in the lower layers. Lightning and hail hazards appeared greatest also around 15 000 ft. Between the cells conditions are smoother. It is suggested that a fuller development of radar to enable the smoother regions to be followed may be the solution of the problem of thunderstorm flying. A. E. M. GEDDES

551.521

627. On the theory of heat-economy of a radiation-transparent medium. H. REUTER. *Tellus*, **1**, 6–14 (*Aug.*, 1949) *In German.*

551.521.3 : 535.436

Non-Rayleigh scattering of infrared solar spectrum in atmosphere. *See Abstr.* 203

551.524.7

628. Atmospheric ozone temperatures as determined by spectroscopic observations from below. W. M. BENESCH. Letter in *Phys. Rev.*, **76**, 863–4 (*Sept.* 15, 1949).

A hot area of the focused lunar image was thrown on the slit of an infrared spectrometer, and so adjusted that the 9·6 μ absorption band of atm. O_3 was just filled in by superposed atm. emission (cf. line-reversal method for flame temps.) The radiative temp. of the O_3 emission will thus be the same as that of the imaged lunar strip. The average temp. for the O_3 layer was −45°C, obtained from 3 observations. Such "effective" temps. are representative only of the ozonosphere as seen from below, the upper O_3 layers being substantially masked by those at the lowest levels. D. R. BARBEE

551.576

629. The albedo of the planet earth and of clouds. S. FRITZ. *J. Met.*, **6**, 277–82 (*Aug.*, 1949).

The albedo of the whole earth is calculated to be 35%, largely on the basis of Danjon's visual lunar measurements. The calculations also give a value of about 0·50 for the average albedo of clouds, which is in better agreement with measurements than the currently accepted value. A.

551.578.1

630. The problem of artificial control of rainfall on the globe. II. The coastal orographic maxima of precipitation in autumn and winter. T. BERGERON. *Tellus*, **1**, 15–32 (*Aug.*, 1949).

551.593.5 : 535.436

Scattered radiation due to atmospheric fog and secondary diffusion. *See Abstr.* 204

551.593.55

631. Radiation of atmospheric sodium. S. F. RODIONOV AND E. N. PAVLOVA. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 2) 251–4 (1949) *In Russian.*

An attempt to apply the photoelectric method to the investigation of the spectrum of the twilight sky. A monochromator-photometer outfit has been used. Photocurrent measurements were conducted rapidly as soon as twilight began. The flaring-up of the D_{Na} line is visible on several photocurrent/wavelength curves each of which corresponds to a certain mean value of the zenith-distance[2] of sun. The emission line is preceded by an absorption line which passes into the emission line at $Z = 95°$. Absorption line having the centre of gravity at 5 893 Å seems to be due to the presence of Na in the atmosphere.

F. LACHMAN

551.594.221 : 621.316.9

632. A new photographic instrument for analyzing lightning flashes. Z. YOSIDA AND M. HANAZIMA. *J. Fac. Sci. Hokkaido Univ.* (*Ser.* 2) **3**, 165–70 (*Aug.*, 1942).

A photographic instrument of new design for analysing lightning flashes was used in the field with good results. It is composed of 10 Leica cameras attached along a revolving steel rod. The cameras are so arranged that a lightning flash occurring in any direction is caught by one of the cameras; i.e. the visual angle is 360°. Revolving the cameras at the rate of 5 rev/s a resolving power as high as 50 μs is obtained, and at the same time the whole series of strokes of a lightning flash can be photographed without overlapping. A.

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.816.1 : 621.396.615.17

633. On equipment for the artificial stimulation of the nerves in the human body. M. KULP. *Funk u. Ton*, **3**, 144–50 (*March*, 1949) *In German.*

Electronic nerve stimulators are described for both diagnostic and therapeutic applications. The pulses are generated by a multivibrator and the frequency of impulse and intermittency (pause) and the relative temporal duration of each can be controlled independently by a variable RC network. The range extends from 10 msec to 1 sec. A glow lamp is arranged to light up during each pulse. The wave is

of rectangular shape, but by means of an induction coil, saw-tooth shapes can be obtained. The equipment combines circuits for faradization, galvanization and electronic stimulation. A variety of frequencies, voltages and waveforms are provided for.

W. SUMMER (R)

612.816.1 : 621.396.615.17

634. Electromedical stimulators. O. B. SNEATH AND E. G. MAYER. *Wireless World*, **55**, 129–32 (*April*, 1949).

Pulse-generating equipment is described for muscle and nerve diagnosis and treatment, capable of producing square pulses of 1 sec to 0·01 msec duration, with repetition rates ranging from < 1/sec to 50/sec. Depending upon the type of treatment, the pulses may have to be controlled in amplitude periodically, or "surged," at rates varying from 6 to 100/min. Furthermore, d.c. and sinusoidal current may be required, again with provision for surging, and also alternate surging involving reversed polarity. The use of 2 or more a.c./d.c. valves in parallel enables the output, ~ 100 mA at 100 V, to be obtained, while a novel form of multivibrator, using a triode and a hexode, reduces the complexity of switching and permits a high ratio between the periods of the 2 phases, e.g. 10–100 μsec pulses at 1 sec intervals. Alternatively, a modified form of Miller integrator can be used. A relaxation type of oscillator, shunted across the grid of the output valve, forms the surge generator. A stabilizing circuit for the h.t. supply, when generating long pulses, is also described. H. G. M. SPRATT (R)

612.816.1 : 621.396.615.17

635. Pulsed stimulator aids medical research. L. A. WOODBURY, M. NICKERSON AND J. W. WOODBURY. *Electronics*, **22**, 84–5 (*Aug.*, 1949).

A flexible constant-current pulse generator is described. A normal type of multivibrator has its frequency controlled by component switching and ganged grid potentiometers. The output, after differentiation and clipping, passes to a 1-shot multivibrator, where the pulse width is controlled by variation of the grid-anode capacitors. The output stage consists of a 6L6 with the tissue load connected either directly in the anode lead or, if a balanced output is required, through a transformer with the secondary centre tap earthed. Output amplitude is controlled by varying the bias of a diode shunted across the 6L6 grid circuit. The frequency range is 0·1–1 000 pulses/sec and 4 pulse widths of 1·5, 1·0, 0·5 and 0·025 msec are provided. Some distortion occurs on long pulses when the transformer is included. The output amplitude range is 0–100 mA. A timing device enables the instrument to be set to operate for a specific time interval. Uses include single and repetitive stimulation of sensory and motor nerves, direct stimulation of skeletal and cardiac muscle, determination of pain thresholds, and the production of electrically induced seizures. See also preceding Abstr. H. G. M. SPRATT (R)

612.84 : 535.317.4

The spherical aberration of the eye and its variation with the state of accommodation. *See Abstr.* 124

614.8 : 539.16

636. Disposal of radioactive wastes by biological methods. I. C. C. RUCHHOFT. *Atomics*, **1**, 12–15 (*Aug.*, 1949).

Reasons are given for preferring the activated sludge process to the trickling filter process in applying biological techniques to radioactive problems. The principles governing the sludge process are outlined, with emphasis on the important part played by zoogloeal bacteria. In expts. on Pu solutions it was found that sludge treatment for 24 hr reduced the activity in the liquid from $\sim 10^5$ c/min/litre to $\sim 4\,000$ c/min/litre. A. P. FRENCH

615.849

637. Depth dose data and isodose distributions for radiation from a 22 MeV. betatron. H. E. JOHNS, E. K. DARBY, R. N. H. HASLAM, L. KATZ and E. L. HARRINGTON. *Amer. J. Roentgenol. and Radium Ther.*, **62**, 257–68 (*Aug.*, 1949).

615.849

638. Two devices for improving accuracy in X-ray beam direction. I. G. BROWN AND J. L. HOWARTH. *Brit. J. Radiol.*, **22**, 605–8 (*Oct.*, 1949).

615.849 : 539.165

639. A new beta-ray applicator using fission products. H. F. FREUNDLICH. Letter in *Nature, Lond.*, **164**, 308–10 (*Aug.* 20, 1949).

The fission product chains $Ru^{106} \rightarrow Rh^{106} \rightarrow Pd^{106}$ and $Ce^{144} \rightarrow Pr^{144} \rightarrow Nd^{144}$ are of possible value in radiotherapy in giving highly penetrating β particles (4 MeV and 3 MeV respectively) with long $\frac{1}{2}$-lives (290 d and 175 d respectively). The distribution of dose in a perspex block produced by β-rays from the Ce^{144} chain was studied by measuring the exposure of a film embedded in the block. The roughly exponential decrease in the ionization, with depth in the block, which would arise from the absorption of a continuous β spectrum, was avoided by using a collimated beam of β-rays and scattering out of the beam as many as possible of the low energy particles by means of Au and Al foils. In this way, a fairly uniform radiation dosage was obtained over a depth of 3 or 4 min in the perspex. L. R. SHEPHERD

615.85 : 534.321.9

640. The mechanical and biological effects of ultrasonics based on the analogy between sound and heat. SKUDRZYK, E. *Acta Phys. Austriaca*, **3** (*No.* 1) 56–65 (1949) *In German.*

Ultrasonics have been used recently in the curative treatment of a number of diseases such as deafness and rheumatism, while experiments have been made on the treatment of cancer. The internal friction of the material to the vibrations induced by the ultrasonic generators produces heat and coagulation. It is considered that ultrasonic vibrations operating at 500 kc/s are more effective physiologically than heat because they operate at a much lower frequency, the more important energy transfer occurring in heat at a frequency of the order of 4×10^{12} c/s. It seems probable that the effect of the ultrasonic vibrations depends on their amplitude, and, for a given energy density, the amplitude of the ultrasonic vibration will be $\geqslant$ that of thermal movements, and, moreover, ultrasonic vibrations produce greater thermal expansion and cavitation. The treatment given is mainly theoretical. A. C. WHIFFIN

TECHNICAL MATERIALS 66/67

666 : 536.212.3

Thermal conductivity of glasses at low temperatures. *See Abstr.* 217

PHOTOGRAPHY 77

771.447.1 : 621.327.4

641. The gas arc—a new source of light for photography. H. W. CUMMING. *Photogr. J., B.*, **89**, 58–62 (*May–June*, 1949).

The gas arc is a forced liquid-cooled lamp in which a high current density discharge through Xe produces at 5 kW a luminous efficiency of ~30 lumen/W together with a radiation almost identical with natural sunlight. Design, construction and dimensions of the standard lamp and flow jacket are described, the method of operation from 200/250 V a.c. and from 100/220 V d.c. mains is outlined and a suitable circuit diagram given. The relation between arc voltage and current over the range of 1–5 kW is discussed. Luminous characteristics, including spectral energy distribution, colour and luminous efficiency as a function of arc current are provided. The main application as a powerful flood-lighting source for colour processes and colour photography is indicated. A.

771.447.9 : 621.327.3/4

642. Recent developments in high-intensity metal vapour discharge lamps. E. H. NELSON. *Photogr. J., B.*, **89**, 54–8 (*May–June*, 1949).

Describes current forms of high-intensity Hg vapour lamps, their operating characteristics and their performance, with particular reference to use for photographic purposes, especially in cinema studios. The effect of addition of Zn and Cd on the spectral distribution is described. J. W. T. WALSH (R)

771.53 : 539.16.08

The fogging of photographic film by radioactive contaminants in cardboard packaging materials. *See Abstr.* 440

778 : 621.385.832 : 535

Cathode-ray tube application in photography. *See Abstr.* 108

778.3 : 537.533

Studies of photoelectrons in photographic plates. *See Abstr.* 306

778.3 : 537.534

643. Fading of proton tracks in vacuum. K. B. MATHER. *Phys. Rev.*, **76**, 486–7 (*Aug.* 15, 1949).

The fading of the latent images due to protons has been compared for photographic emulsions maintained in air and in vacuum after the exposure was made. The fading in vacuum was ~ 10% of that in air indicating a purely chemical origin for the phenomenon of fading. At the present time it is speculative whether the residual 10% arises from the same source in which case it could be eliminated by merely improving the vacuum, or comes from an altogether distinct process. Some suggestions are advanced concerning a possible Ag atom evaporation process. A.

778.3 : 539.1

On the measurement of the mass of charged particles by grain counts in sensitive emulsions. *See Abstr.* 522

778.37 : 621.383

644. A new method for the photographic study of fast transient phenomena. J. S. COURTNEY-PRATT. *Research, Lond.*, **2**, 287–93 (*June*, 1949).

A method is described for photographing details occurring in 10^{-7} to 10^{-8} sec. An image converter tube has been used to take photographs of the detonation of explosives of the same general form as those obtained with drum cameras. The display of the event as a function of time has been achieved by electronic deflection of the electron stream. The method can be developed to give better resolution, higher useful intensity, and writing speeds about 100 times faster than have been obtained with drum or mirror cameras. Single conventional photographs may be taken using an image converter tube and applying the supply voltage as a pulse of short duration. The exposures can be as short as at least as the best that are possible with flash photography and Kerr cells. A method is described for taking a series of exposures with a frame interval of the order of 1 μs. Separation of the individual frames is accomplished by applying suitable deflecting fields to the image converter tube. These methods may also be simply adapted for use with X-ray illumination. The range and versatility of the method make it applicable to the general study of fast movements so that it can prove useful in the investigation of such problems as the detonation of explosives, combustion in engines, projectile and rocket flight, projectile target penetration, spark and discharge phenomena and schlieren studies of shock waves. A.

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